FILTER ELEMENTS AND FILTERING METHODS

This application claims priority of United States Application No. 60/155,138, which was filed on September 22, 1999 and is incorporated by reference.

Background of the Invention

This invention relates to a filter element containing a functional drainage layer and to a filtering method employing a functional drainage layer.

Filter elements frequently include a drainage layer disposed on one or both of the upstream and downstream sides of a filter layer of the filter element. A drainage layer can enhance the performance of a filter element by maintaining a space for fluid flow along a surface of a filter layer so that as much of the area of the filter layer as possible can be effectively used for filtration. Depending on its structure, a drainage layer may also physically support a filter layer to enable the filter layer to resist forces acting on the filter layer maintaining the integrity and shape of the filter layer, particularly when the filter layer is made of a very thin material. A fluid passing through a conventional filter element typically undergoes substantially no modification while within a drainage layer, substantially all modification of the fluid taking place as the fluid passes through the filter layer. Since a drainage layer may occupy a significant portion of the volume of a filter element, if no modification takes place in the drainage layer, much of the volume of the filter element may be under utilized.

Summary of the Invention

The present invention provides a filter element comprising with a drainage layer which can treat a fluid passing through it while providing drainage or physical support for a filter layer of the filter element. A drainage layer which treat a fluid passing through it will be referred to as a functional drainage layer.

The present invention also provides various methods of filtering fluids with a filter element having a functional drainage layer.

A filter element according to the present invention includes a filter layer for filtering a fluid and a functional drainage layer containing a functional material capable of providing drainage for the filter layer and of treating the fluid as the fluid passes through the functional

drainage layer. The functional drainage layer may be disposed on an upstream and/or a downstream side of the filter layer.

A method of using a filter element according to the present invention comprises passing a fluid through a functional drainage layer containing a functional material and through a filter layer. The fluid is filtered as it passes through the filter layer, and it is treated by the functional material as it passes through the functional drainage layer.

A filter element according to the present invention can be used to process a wide variety of fluids, including gases, liquids, and multi-phase combinations, such as mixtures of gases and liquids, and it can be employed to perform a wide variety of filtering processes, such as removal of particles from a fluid (particle filtration), separation of one or more substances from a fluid, coalescing, transfer of dissolved substances between two fluids, and concentration of a process fluid, all of which will be collectively referred to as filtration. Particles which may be removed from a fluid when the filter element is used for particle filtration may range in size from coarse particles (generally defined as particles measuring approximately 0.1 mm in diameter and above) down to particles and/or substances in the ionic range (generally defined as particles measuring approximately 10^{-7} to approximately 10^{-5} mm in diameter). Thus, among the types of particle filtration which the filter element may be used to perform are coarse particle filtration, fine particle filtration, microfiltration, ultrafiltration, nanofiltration, and reverse osmosis.

The treatment of fluid performed by the functional drainage layer is a process, other than mechanical separation, producing some change in the characteristics of the fluid passing through it. Substantially all mechanical separation, e.g., removal of particles from the fluid, is preferably performed by the filter layer of the filter element, with the functional drainage layer performing a different type of treatment, such as one involving a sorptive, chemical and/or catalytic process.

Filter elements embodying the present invention may be disposable elements which are intended to be discarded when they become loaded with particles or otherwise reach their capacity for filtering. Filter elements embodying the invention may also be reusable elements which can be cleaned or otherwise regenerated to restore their filtering ability, either while still installed in a housing or after being removed therefrom, to enable the filter elements to be reused.

A filter element embodying the present invention provides a drainage layer for treating a fluid flowing through it while providing drainage for a filter layer of the filter element,

thereby increasing the efficiency with which the volume of the filter element is utilized.

Although the present invention will be described with respect to a number of preferred embodiments, the present invention is not limited to the specific structures of those embodiments. For example, one or more features of one embodiment may be freely combined with one or more features of another embodiment without departing from the scope of the present invention.

Brief Description of the Drawings

Figures 1-4 are transverse cross-sectional views of portions of various configurations of pleated filter elements according to the present invention.

Figure 5 is a transverse cross-sectional view of a configuration of a spirally wound filter element according to the present invention.

Figure 6 is a schematic isometric view of a configuration embodiment of a filter element according to the present invention comprising a plurality of stacked layers.

Figure 7 is a vertical cross-sectional view of an example of a segment filter arrangement according to the present invention.

Description of Preferred Embodiments

A filter element according to the present invention preferably includes at least one filter layer containing a filter medium capable of filtering a fluid passing through it, and at least one functional drainage layer disposed proximate, e.g., opposite, a surface of the filter layer to provide drainage for the filter layer and to treat a fluid passing through it by at least one method other than mechanical separation of solids.

The filter element can have any desired configuration, such any of those used for conventional filter elements, with or without a drainage layer. A few examples of suitable configurations are a pleated configuration, a spirally wound configuration, a stacked layer arrangement, or a segment filter arrangement. Flow through the filter element can be in a variety of directions, such as generally radially between a center and an exterior of the filter element, in a lengthwise direction of the filter element, in a spiral direction, or in a combination of directions. The filter element may be used to perform dead end filtration in which all of a process fluid being filtered passes through the filter layer, or it may be used to perform cross flow filtration in which only a portion of the process fluid passes through the filter layer as the process fluid passes along the surface of the filter layer.

The filter layer can be in a variety of forms, depending on the intended type of filtration and the characteristics of fluid being filtered, including but not limited to a mass of fibers, fibrous mats, woven or non-woven fibrous sheets, porous membranes such as supported or unsupported microporous membranes, porous foams, and porous metals or ceramics. The filter layer may have only a single layer or it may comprise a plurality of layers, each layer having the same or different properties. The material of which the filter layer is formed is also not restricted. For example, it can be made of natural or synthetic polymers, metals, and ceramics. In many preferred embodiments, the filter layer may have a removal rating of about 75μ or less, preferably less than about 25μ, more preferably less than about 15μ. For example, the removal rating of the filter layer may be in the range from about 3μ to about 15μ. The filter layer may alternatively have a removal rating of less than about 3μ.

Since one purpose of the functional drainage layer is to provide drainage for the filter layer, it preferably has a lower resistance to edgewise flow (flow through the functional drainage layer in a direction parallel to its surface) than the filter layer. For example, the edgewise flow resistance of the functional drainage layer may be less than about 50%, preferably, less than about 20% and more preferably less than about 10%, of the edgewise flow resistance of the filter layer. The functional drainage layer is preferably much more coarse than the filter layer. For example, the functional drainage layer may be sufficiently porous so as to perform substantially no removal of particles from the process fluid, with substantially all particle removal, if occurring in the filter element, being performed by the filter layer. However, it is also possible for the functional drainage layer to perform some particle removal.

The functional drainage layer also contains a functional material capable of performing a function to treat a fluid passing through it. The functional material may be in a variety of forms, such as in the form of functional particles of a variety of sizes and shapes disposed on the surface of and/or, more preferably, within the drainage layer. Alternatively or additionally, the functional material may be in the form of functional fibers which are made of a functional material or have been treated to make them functional, or a thin layer of functional material which may be deposited, e.g., coated, on or within a porous substrate, such as a fibrous sheet.

The functional material is preferably an integral part of the functional drainage layer. For example, the functional material may be bonded to, coated on, immobilized in, and/or

formed as the functional drainage layer. By providing the functional material as an integral part of the functional drainage layer, the functional material resists separation from the drainage layer as fluids flow through the functional drainage layer. Preferably, the functional material is included substantially throughout the functional drainage layer. In many embodiments, the functional material may be included substantially uniformally throughout the functional drainage material. Alternatively, the functional material may be included non-uniformally throughout the functional drainage layer.

The functional drainage layer may have only a single layer or it may comprise a plurality of layers, each layer having the same or different properties. Given the variety of forms which the functional material and/or the functional drainage layer may take, the functional drainage layer can have a wide variety of structures. A few examples are as follows:

(a) a woven or non-woven fibrous sheet of any type of fibers in which or on which functional particles or functional fibers are integrated;

(b) a woven or non-woven fibrous sheet made entirely or in part of functional fibers;

(c) a woven or non-woven, e.g., extruded, mesh comprising strands of any type of material in which or on which functional particles or functional fibers are immobilized;

(d) a woven or non-woven, e.g., extruded, mesh made entirely or in part of functional fibers;

(e) a porous open-celled foam containing functional particles or functional fibers;

(f) a laminated structure, e.g., including two or more nonwoven, woven, or mesh layers pressed and/or bonded together where at least one of the layers includes the functional material and/or where the functional material is sandwiched between the layers; and

(g) a porous sheet of bonded particles, e.g., sinter bonded or resin bonded particles, of functional material.

Functional drainage layers comprising fibrous sheets, and especially non-woven sheets, in which or on which particles or fibers of functional material are integrated are particularly suitable because they can be readily manufactured so as to have desired properties such as a desired thickness, porosity, or functional particle size and can be made of a variety of materials. Examples of drainage layers are disclosed in United States Patent No. 5,543,047 which is incorporated by reference.

Methods of manufacturing porous functional sheets of this structure are well known in the art and these sheets may be used, in accordance with the present invention, as functional

drainage layers. Porous functional sheets are described, for example, in U.S. Patent No. 3,971,373 entitled "Particle-Loaded Microfiber Sheet Product And Respirators Made Therefrom", U.S. Patent No. 5,605,746 entitled "Fibrous Structures Containing Particulate And Including Microfiber Web", U.S. Patent No. 5,674,339 entitled "Process For Fibrous Structure Containing Immobilized Particulate Matter", and U.S. Patent No. 5,885,696 entitled "Patterned Fibrous Web", which are incorporated by reference. One example of a commercially available product which can be effectively used in the present invention as this type of functional drainage layer is sold by AQF Technologies LLC of Charlotte, North Carolina.

The functional drainage layer can perform a variety of functions in treating the fluid, including removal of one or more substances from a fluid stream by processes such as adsorption, chemical reaction, or amalgamation, modification of one or more substances in a fluid stream by chemical reaction, catalysis, or other process without removing the substances from the fluid stream, or delivery of a substance into the fluid stream by physical or chemical action of the functional material in the functional drainage layer. A few examples of possible functional materials for performing one or more of these functions include activated carbon, silica, zeolite, molecular sieves, clay, alumina, sodium bicarbonate, ion exchange resins, catalytic agents, metal oxides, oxidizing agents, reducing agents, biocidal agents, fungicidal agents, virucidal agents, air freshening agents, and perfuming agents. Thus, the functional materials may be sorbents, reactants, catalysts, or any other suitable type of material. A few specific examples of functions which the functional drainage layer might perform are as follows:

(a) the removal of copper and/or cobalt from coolant water for power plants using a functional material such as that available under the trade designation Purolite S950 in a functional drainage layer;

(b) the removal of acid from oils or other liquids using an ion exchange resin such as that available under the trade designation Purolite A103 in a functional drainage layer;

(c) the removal of odors from cabin air in an aircraft using a functional material such as activated carbon in a functional drainage layer;

(d) the removal of Cu or other ions from aircraft fuel using a functional material such as that available under the trade designation Purolite S950 in a functional drainage layer; and

(e) the separation of proteins from biological or pharmaceutical fluids or other liquids using a functional material such as any of a wide variety of affinity sorbents in a functional drainage layer.

The amount of functional material which may be integrated with the functional drainage layer depends on factors such as the desired treatment of the fluid and the desired edge flow resistance of the functional drainage layer. Increasing the amount of functional material integrated with the functional drainage layer increases the effectiveness and/or efficiency with which the functional material treats the fluid flowing through the functional drainage layer. However, it may also increase the edgewise flow resistance of the functional drainage layer and, therefore, decrease the ability of the functional drainage layer to effectively distribute or drain fluid to or from the filter layer. Generally, the amount of functional material integrated with the functional drainage layer is preferably as large as desired to treat the fluid while still providing adequate drainage to the filter layer.

Where the functional material is in the form of particles, e.g., powder or fiber, the nominal size of the particles may depend on such factors as the desired treatment of the fluid, the desired edge flow resistance of the functional drainage layer, and the desired spacing between filter layer surfaces. Decreasing the nominal size of the particles may increase the effectiveness and/or efficiency of the treatment but may also increase the edgewise flow resistance of the drainage layer. Further, larger particles can act as spacers which function to separate surfaces of the filter layer, for example, in pleated filter elements, thereby augmenting the drainage properties of the functional drainage layer.

In many preferred embodiments, the functional drainage layer comprises a fibrous, e.g., nonwoven sheet having particles of functional material integrated within the sheet, e.g., by bonding the fibers of the fibrous sheet to the particles of functional material. Alternatively, the functional drainage layer may comprise two fibrous, e.g., nonwoven, sheets and functional material sandwiched between them. For many applications the amount of functional material may be in the range from about 50 grams/m^2 or less to about 1000 grams/m^2 or more, more preferably from about 100 grams/m^2 to about 500 grams/m^2. The nominal size of the particles of functional material may be in the range from about 50ì to about 1/8 inch. For many functional drainage layers the thickness of the drainage layer is preferably in the range from about 10 mils to about 125 mils and, more preferably, in the range from about 15 mils to about 50 mils, and the nominal size of the particles of functional material is preferably in the range from about 10% to about 100%, more preferably, from

about 10% to about 75%, and, even more preferably, from about 20% to about 60%, of the thickness of the functional drainage layer.

The functional drainage layer may be on either the upstream or downstream side of the filter layer or functional drainage layers may be on both sides of the filter layer. If functional drainage layers are on both sides of the filter layer, the two functional drainage layers may be similar or dissimilar and perform the same or different functions from each other. A single functional drainage layer may be employed on one side of a filter layer, or a plurality of functional drainage layers may be used in combination on the same side of the filter layer.

In many cases, the functional drainage layer is preferably not attached to the filter layer, except to the extent that fibers in the two layers may become enmeshed with each other. However, depending upon the structure of the functional drainage layer and the filter layer, they may be joined to each other by bonding, for example, to enable them to be handled as a single unit. The functional drainage layer may but need not immediately adjacent to the filter layer. For example, an intervening layer, such as a cushioning layer or a different type of drainage layer, may be disposed between the functional drainage layer and the filter layer.

Each functional drainage layer may extend over all or a portion of the area of a side of the filter layer. For ease of manufacture, it is frequently convenient if the functional drainage layer and the filter layer are coextensive, but alternatively, there may be regions of the filter layer along which no functional drainage layer is present, or a functional drainage layer may be installed on part of the area of a surface of the filter layer, and a different type of drainage layer may be installed on the remainder of the area of that surface. Alternatively, a functional drainage layer may include regions which include a functional material and regions which do not include any functional material.

The flow characteristics (such as the edgewise flow resistance) of the functional drainage layer can be selected in the same manner as they would be for the case of a conventional drainage layer based, for example, on characteristics such as the desired flow rate and/or flow distribution through the filter element and the desired pressure drop.

The direction of fluid flow through the functional drainage layer will depend upon the configuration of the filter element. In preferred embodiments of the invention, flow through a substantial portion, e.g., more than about 40%, of the functional drainage layer is preferably primarily in the edgewise direction of the functional drainage layer between the interior and exterior surfaces of the functional drainage layer. For example, when the pleats of a filter

element are pressed against one another over a substantial portion or substantially all of the height of each pleat, e.g., over about 40%, 50%, 75%, 95% or even 100% of the height of the pleat, fluid flow in the functional drainage layer may be primarily in the edgewise direction over much or all of the area of the functional drainage layer. In contrast, in preferred embodiments, flow through the filter layer is primarily in its thickness direction rather than in its edgewise direction over most of its area.

For example, in a cylindrical filter element used for dead-end filtration fluid flow may be directed generally radially inside-out, where inner layers are upstream of outer layers, or outside-in, where outer layers are upstream of inner layers. Fluid may enter an upstream functional drainage layer, for example, at the roots (or crests) of the pleats. The fluid then passes edgewise through the upstream functional drainage layer and is distributed by the functional drainage layer along most or, preferably, substantially all of the upstream surface of the filter layer, even those regions of the pleat most remote from the roots (or crests) of the pleats. From the upstream surface of the filter layer, the fluid passes in the thickness direction through the filter layer to the downstream surface of the filter layer. From the downstream surface of the filter layer, the fluid may enter a downstream functional drainage layer. The fluid is then drained from most or, preferably, substantially all of downstream surface of the filter layer by passing edgewise through the downstream functional drainage layer to the crests (or roots) of the pleats, where it exits the filter element. As the fluid passes through the functional drainage layer(s), it is treated by the functional material integrated with the functional drainage layer. As the fluid passes through the filter layer, it is filtered.

The useful lifespan of the functional drainage layer will depend upon various factors, such as the nature of the functional material, the amount and surface area of the functional material, and the flow rate through the functional drainage layer. To maximize efficiency, the functional drainage layer may be arranged to have a service life similar to that of the filter layer. For example, the functional drainage layer may be arranged so that the functional material becomes depleted at substantially the same time that the filter layer becomes loaded with particles so as to require its replacement.

In addition to a filter layer and one or more functional drainage layers, a filter element embodying the present invention can include any of the components which can be employed in conventional filter elements, such as end caps, drainage layers which do not include a functional material, cushioning layers, reinforcing members such as an internal core or an external cage, an external wrap member, a support plate, seals such as O-ring seals and/or

connectors for connecting two or more filter elements in series. If a functional drainage layer is disposed on the downstream side of a filter layer, it may be desirable to dispose a final filter layer on the downstream side of the functional drainage layer to capture any functional material which may come loose from the functional drainage layer and prevent the functional material from travelling downstream from the filter element. Such a final filter layer need only be fine enough to stop the functional material and can generally be more porous than the main filter layer of the filter element.

As mentioned above, a filter element employing a functional drainage layer can have configurations similar to those used for conventional filter elements. In general, a functional drainage layer can be substituted for a conventional drainage layer, so manufacturing techniques applicable to a conventional filter element can be employed for a filter element having one or more functional drainage layers. Figures 1-7 illustrate a few examples of various possible configurations.

Figure 1 illustrates a transverse cross section of an example of a configuration in the form of a cylindrical filter element having axially extending pleats, i.e., pleats having a length extending generally in the axial direction of the filter element. The pleats are formed of a pleated multilayer composite, which in the present example is a three-layer composite of an inner drainage layer 10, an outer drainage layer 11, and a filter layer 12 sandwiched between and directly contacting the two drainage layers 10, 11. One or both of the drainage layers 10, 11 is a functional drainage layer of any of the types described above. The pleated composite may be arranged in a cylindrical form and may be disposed between an inner perforated core 13 and an outer perforated cage 14 with the pleats directed radially outward from the core 14. The roots and legs of the pleats are shown pressed against each other from the radially inner portion of the pleats along a substantial portion, e.g., about 40% or more, of the height of the pleats. The crests and the outer portions of the legs may be spaced from one another.

In a dead-end mode of operation, a process fluid may flow substantially radially through the filter element (either radially inwardly or outwardly). The fluid flows edgewise through the upstream drainage layer along substantially all of the upstream surface of the filter layer 12. The fluid is then filtered as it flows in the thickness direction through the filter layer 12 of the composite. The fluid then flows from the downstream surface of the filter layer 12 edgewise along the downstream drainage layer. As the fluid flows through the drainage layers 10 and 11, it is treated by the functional material present in one or both of the drainage layers. One or both lengthwise ends of the filter element will typically be open to

enable fluid to be introduced into or removed from the core 13. Instead of flowing generally radially through the filter element, fluid may instead flow through the filter element in the axial direction thereof, e.g., in a cross flow mode of operation, edgewise in either the radially inner or radially outer drainage layers.

Figures 2-4 illustrate examples of configurations of cylindrical filter elements embodying the present invention which have axially extending pleats but in which adjoining legs of the pleats contact each other over substantially all of the height of the legs around at least a portion of the circumference of the filter element. Having adjoining legs of the pleats contact each other over substantially all of their height reduces the amount of unused space within a filter element, so it enables the surface area of a filter layer in a filter element of a given size to be significantly increased. It also provides more uniform flow conditions over the height of the legs compared to a configuration such as that shown in Figure 1, resulting in an increase in the dirt capacity and/or service life of the filter element. Furthermore, contact between adjoining legs of the pleats restrains the pleats from shifting during operation of the filter element, resulting in less wear on the pleats and a longer life for the filter element. In preferred embodiments in which adjoining leges contact each other over substantially all of the height of the pleats, the contact is over a continuous region in the height direction extending for at least about 50% of the height, still more preferably for at least 75% of the height, and yet more preferably for at least 95% of the height. The continuous region may also extend in an axial direction of the filter element, such as preferably for at least approximately 50%, more preferably for at least approximately 75%, and still more preferably for approximately 95-100% of the axial length of the filter element.

Many different configurations in which adjoining legs of pleats contact each other over substantially all of their height are possible. Figure 2 is a transverse cross-sectional view illustrating an example of a configuration in which pleats of a filter element are in a state in which the pleats extend in an arcuate or angled fashion or in a straight, non-radial direction such that the radially outer portions of the pleats are displaced in the circumferential direction of the filter element with respect to the radially inner portions of the pleats around at least a portion of the circumference and more preferably around substantially the entire circumference of the filter element until adjoining legs of the pleats contact each other on both the radially inner and outer sides of the pleats. When the pleats are shaped in this manner, each pleat has a height which is greater than (D-d)/2 and less than $(D^2-d^2)/[4(d+2t)]$ where D and d are the outer and inner diameters at the crests and roots of the pleated filter

element and t is the effective thickness of a pleat leg. The pleats can be retained in this state by a retaining member surrounding the pleats, such as an external cage, a wrap member, a tube, a flexible sleeve, strings, or bands. Some examples of methods of making a filter element with pleats of this type are described in U.S. Patent No. 5,543,047. In Figure 2, the pleats may be formed from a composite including a filter layer 20 sandwiched between two drainage layers 21 and 22, at least one of the drainage layers being a functional drainage layer, as in Figure 1. As in Figure 1, the pleats may be disposed between reinforcing members, such as a perforated core 23 along the inner periphery of the pleats and a perforated cage 24 disposed along the outer periphery of the pleats.

In one possible dead end mode of operation of the filter element of Figure 2, a process fluid flows substantially radially through the filter element (either radially inwardly or outwardly) in a manner similar to that described with respect to the filter element of Figure 1. In another possible cross flow mode of operation, a process fluid flows in substantially the lengthwise direction of the filter element within one of the drainage layers 21 and 22. Some examples of many possible flow paths for a filter element having a configuration like that shown in Figure 2 are described in United States Patent Application Number 60/099,663 entitled "Fluid Treatment Element And Fluid Treatment Method", which is incorporated by reference. A process and/or permeate fluid flowing through the filter element of Figure 2 passes edgewise through the drainage layers 21 and 22 and in the thickness direction through the filter layer 21. Fluid is filtered as it passes through the filter layer 21, and fluid is treated by a functional material as the fluid passes through one or both of the drainage layers 21 and 22.

Figure 3 is a transverse cross section illustrating another example of a configuration of a hollow cylindrical pleated filter element in which the adjacent legs of pleats are made to contact each other over substantially all of the height of the legs by inserting wedges 33 or other members between the pleats at intervals around the filter element. The wedges 33 compress the pleats in a circumferential direction of the filter element so as to eliminate spaces between adjacent legs without producing any substantial bending or leaning of the pleats in the circumferential direction of the filter element. Such a filter element is described, for example, in U.S. Patent No. 4,154,688 entitled "Collapse-Resistant Corrugated Filter Element". As in the preceding examples, the illustrated pleats may be formed from a composite including an inner drainage layer 30, an outer drainage layer 31, and a filter layer 32 sandwiched between the drainage layers, with at least one of the drainage layers 30 and 31

being a functional drainage layer. If desired, the filter element may include reinforcing members such as a perforated cylindrical core 34 on the inner periphery and a perforated cylindrical cage 35 on the outer periphery of the pleats.

As is the case with the filter elements of Figures 1 and 2, fluid may flow through the filter element of Figure 3 along a variety of paths. For example, fluid may flow substantially radially through the filter element between the exterior of the filter element and the interior of the core 34, or it may flow through the drainage layers 30 and 31 substantially in a lengthwise direction of the filter element. Fluid flows edgewise through the drainage layers 30 and 31 and in the thickness direction through the filter layer. Fluid is filtered as it passes through the filter layer 32, and it is treated by a functional material present in one or both of the drainage layers 30 and 31 as it passes through the drainage layers.

Pleated configurations of a filter element according to the present invention are also possible which are not cylindrical or hollow. Figure 4 illustrates an example of a configuration of a filter element with a generally block-like overall shape and including a plurality of pleats, each pleat extending generally parallel to the other pleats in generally a straight line. The illustrated pleats may be formed from a three-layer composite of a first drainage layer 40, a second drainage layer 41, and a filter layer 42 sandwiched between the drainage layers, with at least one of the drainage layers 40 and 41 being a functional drainage layer. The pleats are shown with each leg of each pleat contacting an adjoining leg over a substantial portion, preferably substantially all, of its height. Frequently, the pleats will be disposed in a housing 43 such as a frame or other structure which can guide a fluid to be filtered along a desired path through the filter element. Fluid is shown by arrows in the figure flowing in a dead end mode through the filter element in a direction substantially parallel to the height direction of the legs of the pleats, but fluid may flow in a different direction, such as normal to the plane of the figure, for example, in a cross flow mode. As an example, in Figure 4, a process fluid to be filtered can enter the filter element by flowing into the first drainage layer 40 on the upstream side of the filter element (the lower side in Figure 4) edgewise through the upstream drainage layer 40 along substantially the entire upstream surface of the filter layer 42. The process fluid then flows from the first drainage layer 40 in the thickness direction through the filter layer 42 into the second drainage layer 41. The filtered process fluid then flows edgewise through the second drainage layer 41 to the downstream side of the filter element. As the fluid flows through the filter layer 42, it is filtered. As the fluid flows through the drainage layers 40 and 41, it is modified by a

functional material present in one or both of the drainage layers. Any portions of the first drainage layer 40 extending to the downstream side of the filter element may be sealed off in any suitable manner to prevent unfiltered fluid from being discharged from the downstream side of the filter element. For example, a bonding agent 44, a sealing member, or welding can be employed to seal off the end surfaces of the first drainage layer 40.

Figures 5-7 illustrate examples of configurations of non-pleated filter elements embodying to the present invention. Figure 5 shows a transverse cross section of an example of a cylindrical spiral-wound filter element comprising a multilayer composite spirally wrapped around a center of the filter element. The center of the filter element may be hollow or solid, depending upon the intended flow path of fluid through the filter element. The illustrated composite may include a first drainage layer 50, a second drainage layer 51, a filter layer 52 sandwiched between the drainage layers, and a separating layer 53 which adjoins the second drainage layer 51 and separates the two drainage layers 50 and 51 from each other to prevent unfiltered fluid from flowing between the two drainage layers. The separating layer 53 can be either permeable or impermeable to fluid as long as it can prevent the free flow of unfiltered fluid between the drainage layers. At least one of the drainage layers 50 and 51 is a functional drainage layer. The composite is shown wrapped around a hollow, perforated cylindrical core 54 through which fluid can be introduced into or removed from the filter element. A retaining member, such as a cage or a wrap member, may be disposed around the outer periphery of the composite or the composite may be joined to itself along its outer periphery to prevent it from unwrapping. Fluid can flow through the filter element along a variety of paths, such edgewise as along a spiral path through the drainage layers, or edgewise along a path through the drainage layers normal to the plane of the figure in the axial direction of the filter element. In one possible flow path, commonly employed in spiral filter elements, a process fluid is introduced into the filter element via an unillustrated tube inserted into a space 55 near the radially outer periphery of the filter element. From the space 55, the process fluid enters the second drainage layer 51, spreading edgewise within the second drainage layer 51 over the length of the filter element and at the same time flowing spirally within the second drainage layer 51 towards the center of the filter element. From the second drainage layer 51, the process fluid flows in the thickness direction substantially radially through the filter layer 52, is filtered as it does so, and then flows into the first drainage layer 50. Within the first drainage layer 50, the filtered fluid flows edgewise spirally towards the center of the filter element and then into the perforated core 54 for removal from the filter

element. Process fluid may also flow in the opposite direction. being introduced into the core 54 and being removed from the space 55 at the outer periphery of the filter element. As the fluid flows through the drainage layers 50 and 51, it is treated by a functional material present in one or both of the drainage layers in a manner determined by the character of the functional material.

Figure 6 illustrates an example of a configuration of a filter element according to the present invention comprising a plurality of flat sheets stacked atop each other. The stack includes a plurality of flat filter layers 60, each sandwiched between first and second drainage layers 61 and 62, the first drainage layers 61 and/or the second drainage layers 62 being functional drainage layers. The stacked layers 60-62 may be disposed in a housing 63, a frame, or other structure which can guide fluid to be filtered along a desired flow path through the filter element. Each of the first drainage layers 61 is sealed in a suitable manner, such as by a bonding agent 64, a sealing member, or welding on the downstream side of the filter element to prevent the discharge of unfiltered process fluid from it but is open on the upstream side of the filter element to enable process fluid to enter it. Each of the second drainage layers 62 is sealed on the upstream side of the filter element in a similar manner to prevent the entry of process fluid and is open on the downstream side of the filter element to enable filtered fluid to be discharged from it.

In one possible mode of operation, a process fluid to be filtered is introduced into the filter element from the righthand side in Figure 6. Since the upstream ends (the right ends in Figure 6) of the second drainage layers 62 are sealed, the process fluid flows into the first drainage layers 61 and then in the edgewise direction of the first drainage layers 61 towards the downstream side of the filter element. From the first drainage layers 61, the process fluid flows through the filter layers 60 adjoining the first drainage layers 61 to be filtered and then into the second drainage layers 62. Filtered process fluid then flows within the second drainage layers 62 in the edgewise direction thereof to be discharged from the filter element through the downstream ends (the left ends in Figure 6) of the second drainage layers 62. As process fluid flows through the drainage layers 61, 62, it is treated by the functional material present therein.

Figure 7 is a vertical cross-sectional view of another example of a possible configuration of a filter element according to the present invention. This configuration is sometimes referred to as a segment arrangement and typically includes a plurality of thin, generally flat filter elements 70 stacked atop each other along a common axis. The individual

elements 70 may have any peripheral shape but are typically annular for uniformity of flow. Each of the illustrated elements 70 includes an annular support member 71, a filter layer 73 disposed on one or both surfaces of the support member 71, and a drainage layer 74 disposed between the support member 71 and at least of the filter layers 73, with at least one of the drainage layers 74 being a functional drainage layer. The support member 71 may have a completely flat surface, but frequently it has a structure which enables flow within or along the surface beneath the drainage layer 74. For example, in the present example, each support member 71 is an annular disc having a plurality of elongated grooves 72 extending from an opening at the center of the disc towards the outer periphery of the disc. A rigid mesh or a porous member may also be used as a support member. Each filter element 70 may include hubs 75, formed separately from or as part of the support member 71, for creating a gap between the surfaces of the filter layers 73 on adjoining elements 70. In the present embodiment, each of the filter layers 73 and the drainage layers 74 is a disc-shaped member which is sealed to the support member 71 along its outer periphery and to one of the hubs 75 along its inner periphery by bonding, welding, a sealing member, or other manner to prevent unfiltered fluid from bypassing the filter layers 73. While a single filter element 70 can be used by itself, frequently a plurality of elements 70 are used in combination. The filter elements 70 may be stacked atop each other around a perforated core 76, for example, through which fluid can be introduced into or removed from the filter elements 70. Alternatively, a core 76 can be omitted, and the inner peripheries of the support members 71 and the hubs 75 can define a conduit for fluid. The elements 70 may be sealed to the core 76 and/or to each other to prevent fluid from flowing through gaps between the elements 70 or between the elements 70 and the core 76. In a typical mode of operation, a fluid to be filtered flows from the outside of the filter elements 70 through each filter layer 73 to be filtered and into the adjoining drainage layer 74, flows through the drainage layer 74 into the grooves 72 in the support member 71, then flows within the grooves 72 towards the center of the support plate 71, and then flows through the perforations in the core 75 into the interior thereof. The filtered fluid can then flow along the interior of the core 75 for collection or removal from the assembly. As the filtered fluid flows through the drainage layer 74, it is treated by a functional material in the drainage layer 74. Since the grooves 72 in a support member 71 occupy only a portion of the surface of the support member 71, there is typically significant edgewise flow of fluid through the drainage layers 74 along the surface of the support member 71 before the fluid reaches the grooves 72 in the support member 71.

Various aspects of the invention have been described with respect to many embodiments. However, the invention is not limited to these embodiments. For example, one or more of the features of any of these embodiments may be combined with one or more of the features of the other embodiments without departing from the scope of the invention. Further, one or more of the features of any of these embodiments may be modified or omitted without departing from the scope of the invention. Accordingly, the various aspects of the invention include any and all methods and elements encompassed within the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. A filter element comprising a pleated composite including a filter layer having first and second sides, and a first functional drainage layer disposed proximate the first side of the filter layer, the first functional drainage layer comprising a functional material and having a lower edgewise flow resistance than the filter layer.

2. A filter element as claimed in claim 1 wherein the composite has a plurality of pleats, each having first and second legs, the first leg contacting the second leg of the same pleat and the second leg of an adjacent pleat over a substantial portion of the height of the first leg.

3. A filter element as claimed in any preceding claim wherein the first functional drainage layer has an edgewise flow resistance at most approximately 50% that of the filter layer.

4. A filter element as claimed in any preceding claim wherein the first leg contacts the second leg of the same pleat and the second leg of an adjoining pleat over a substantially continuous region extending for a substantial portion of the height of the first leg and over at least fifty percent of an axial length of the filter element.

5. A filter element as claimed in any preceding claim wherein the pleated composite includes a second functional drainage layer disposed on the second side of the filter layer and comprising a functional material and having a lower edgewise flow resistance than the filter layer.

6. A filter element as claimed in any preceding claim wherein the first functional drainage layer comprises a porous fibrous sheet containing the functional material.

7. A filter element as claimed in any preceding claim wherein the first functional drainage layer contacts the filter layer.

8. A filter element as claimed in preceding claim wherein the filter element is

cylindrical.

9. A filter element as claimed in any preceding claim wherein a plurality of the pleats each have a radially outer end displaced in a circumferential direction of the filter element with respect to a radially inner end of the pleat.

10. A filter element as claimed in any preceding claim wherein the pleats are substantially parallel to each other.

11. A filter element comprising a composite of a filter layer and a fibrous sheet comprising a functional material and having a lower edgewise flow resistance than the filter layer, the composite being spirally wrapped around a hollow center of the filter element.

12. A filter element comprising:

a composite of first and second drainage layers and a filter layer disposed between the drainage layers, at least one of the drainage layers comprising a functional material, each drainage layer having a lower edgewise flow resistance than the filter layer, the composite being spirally wrapped around an axis.

13. A filter element as claimed in claim 12 wherein both drainage layers comprise a functional material.

14. A filter element as claimed in any preceding claim wherein a drainage layer comprises a fibrous sheet in which particles of the functional material are integrated.

15. A filter element comprising:

a support plate;

a filter layer disposed on the support plate; and

a drainage layer having a lower edgewise flow resistance than the filter layer disposed between the filter layer and the support plate and comprising a functional material.

16. A filter element as claimed in claim 15 wherein the support plate has an opening through which fluid can flow between opposite surfaces of the plate.

17. A filter element as claimed in claim 15 or 16 wherein the support plate is annular and an opening is at a radial center of the support plate.

18. A filter element comprising a plurality of filter layers, a plurality of first drainage layers, and a plurality of second drainage layers, each of the filter layers being sandwiched between one of the first drainage layers and one of the second drainage layers, each of the drainage layers having a lower edgewise flow resistance than the filter layers, a plurality of the drainage layers comprising a functional material.

19. A filter element as claimed in claim 18 wherein the first drainage layers are sealed off on an upstream side of the filter element and the second drainage layers are sealed off on a downstream side of the filter element.

20. A filter element as claimed in claim 18 or 19 wherein each of the drainage layers comprises a functional material.

21. A filter element as claimed in any of claims 18-20 wherein each of the filter layers and each of the drainage layers is substantially flat.

22. A method of treating a fluid comprising:

passing a fluid through a filter layer and edgewise through a functional drainage layer on a first side of the filter layer of a pleated filter composite to filter the fluid in the filter layer and treat the fluid with a functional material in the functional drainage layer.

23. A method as claimed in claim 22 including passing fluid through a second drainage layer disposed on a second side of the filter layer.

24. A method as claimed in claim 22 or 23 including passing the fluid in an axial direction of the filter element between opposite lengthwise ends thereof.

25. A method as claimed in claim 22 or 23 including passing the fluid primarily in an axial direction of the filter element through the first functional drainage layer.

26. A method as claimed in claim 22 or 23 including passing the fluid through the first functional drainage layer primarily along a height direction of the pleats.

27. A method as claimed in any of claims 22-26 wherein the filter element is cylindrical.

28. A method as claimed in any of claims 22-27 wherein the pleats are parallel to each other.

29. A method of treating a fluid comprising:

passing a fluid in an edgewise direction within a first drainage layer disposed on a first side of a filter layer, then passing the fluid through the filter layer to filter the fluid, and passing the fluid in an edgewise direction within a second drainage layer on a second side of the filter layer, at least one of the drainage layers containing a functional material which treats the fluid passing through it, each drainage layer having a lower edgewise flow resistance than the filter layer.

30. A method of treating a fluid comprising:

passing a fluid through a filter layer disposed on a support member to filter the fluid and through a functional drainage layer disposed between the filter layer and the support member and containing a functional material to treat the fluid with the functional material.

31. A method as claimed in claim 30 including passing the fluid through the filter layer before passing the fluid through the functional drainage layer.

32. A method as claimed in claim 30 Wherein the support member comprises an annular plate having an opening at a center thereof, the method including passing the fluid through the drainage layer in a radial direction of the plate.

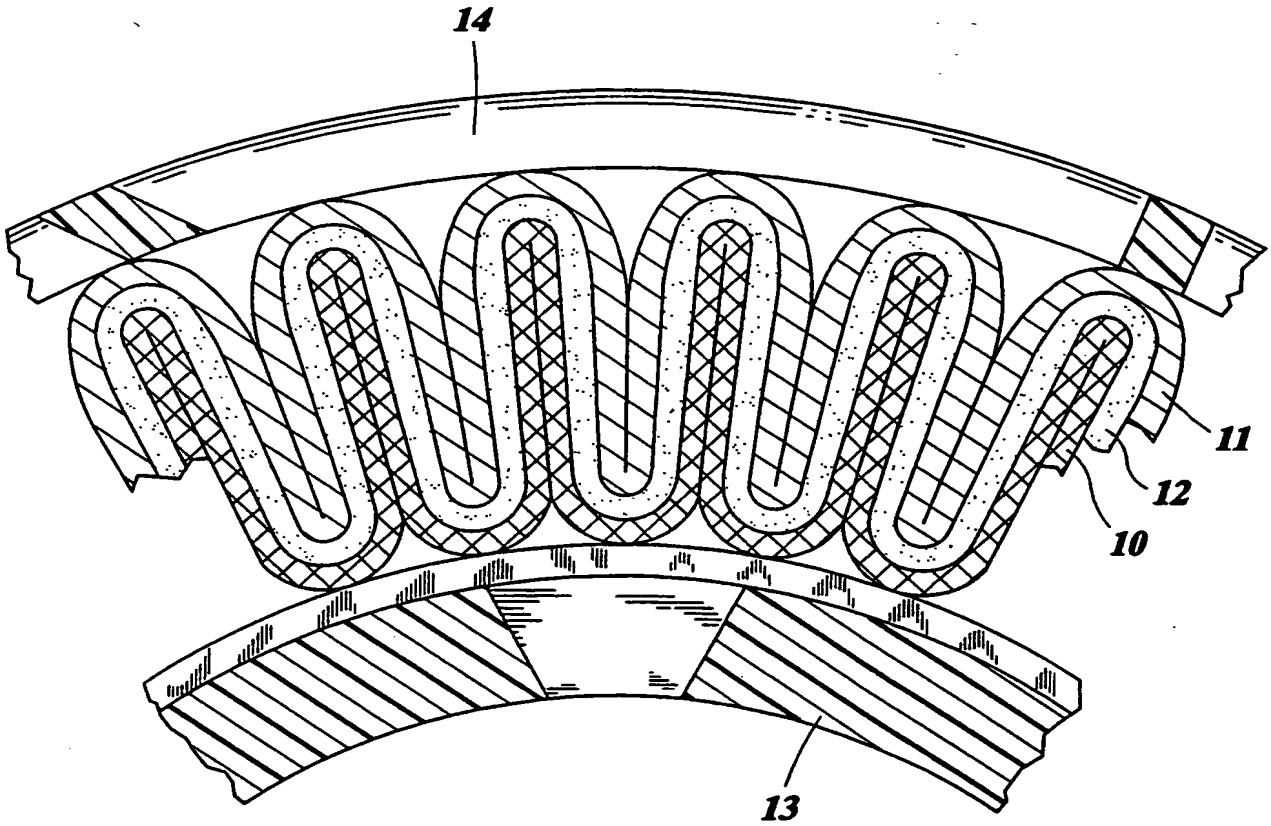

FIG. 1

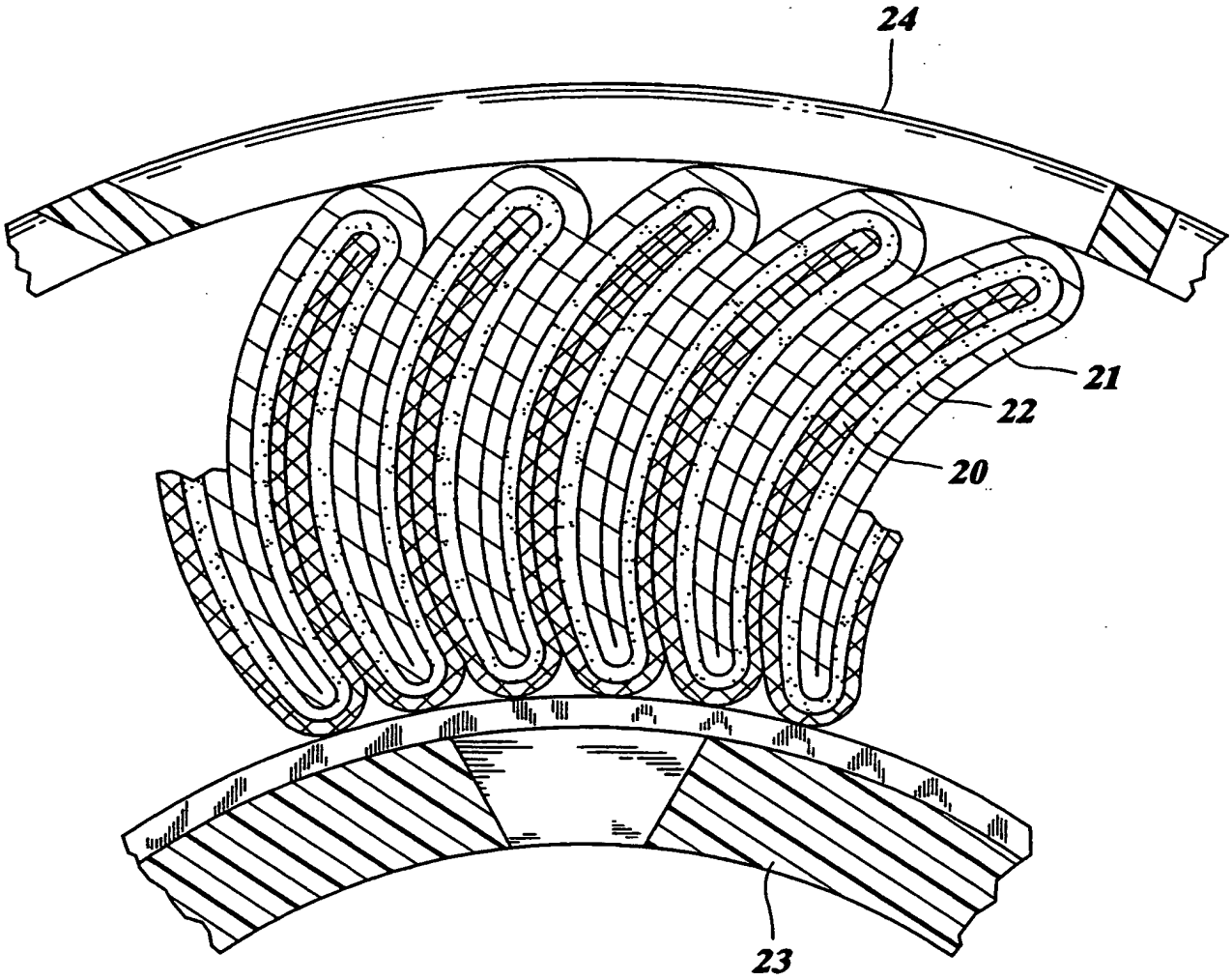

FIG. 2

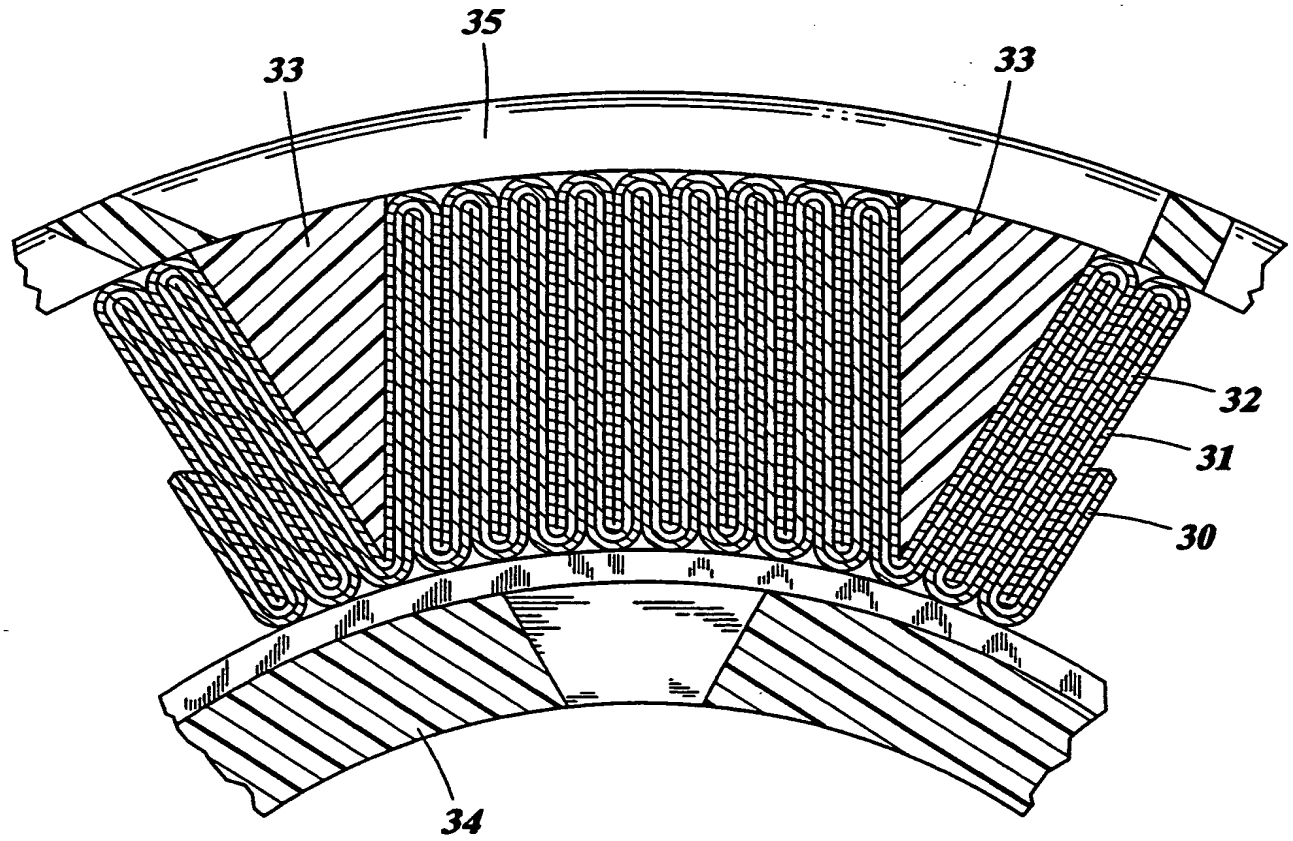

FIG. 3

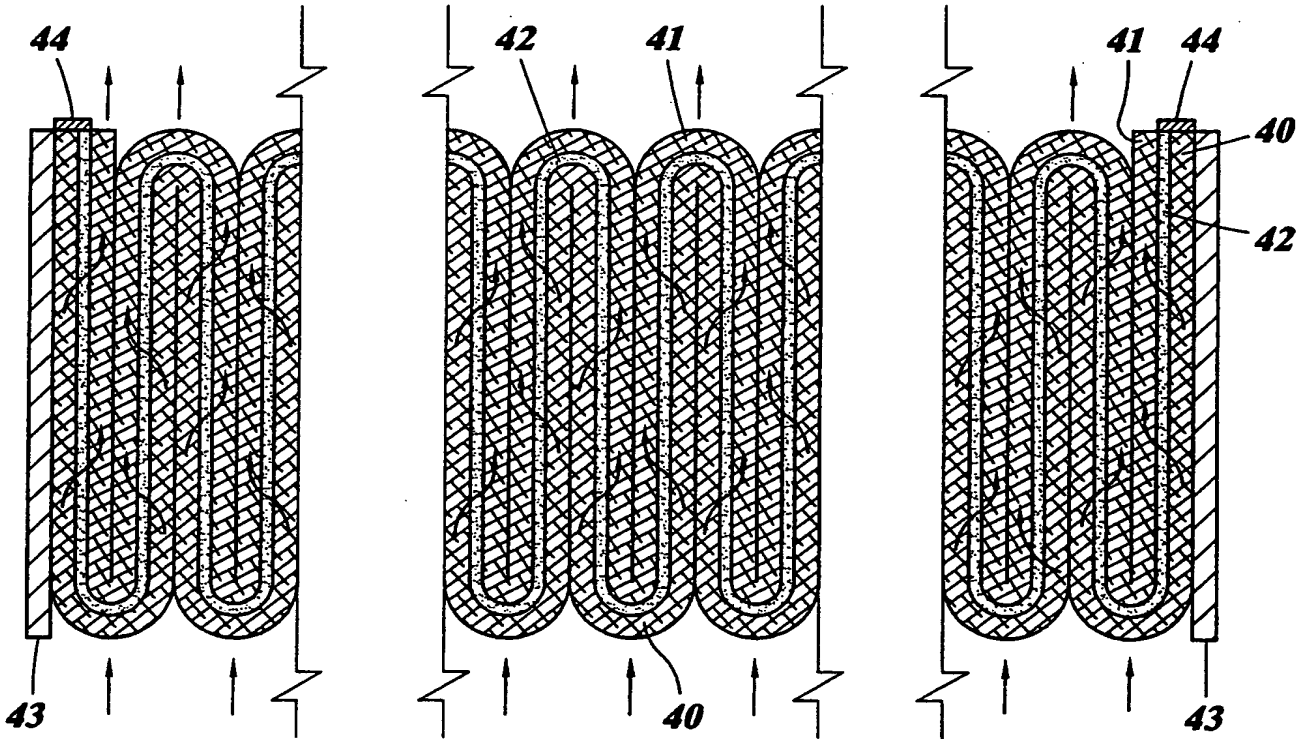

FIG. 4

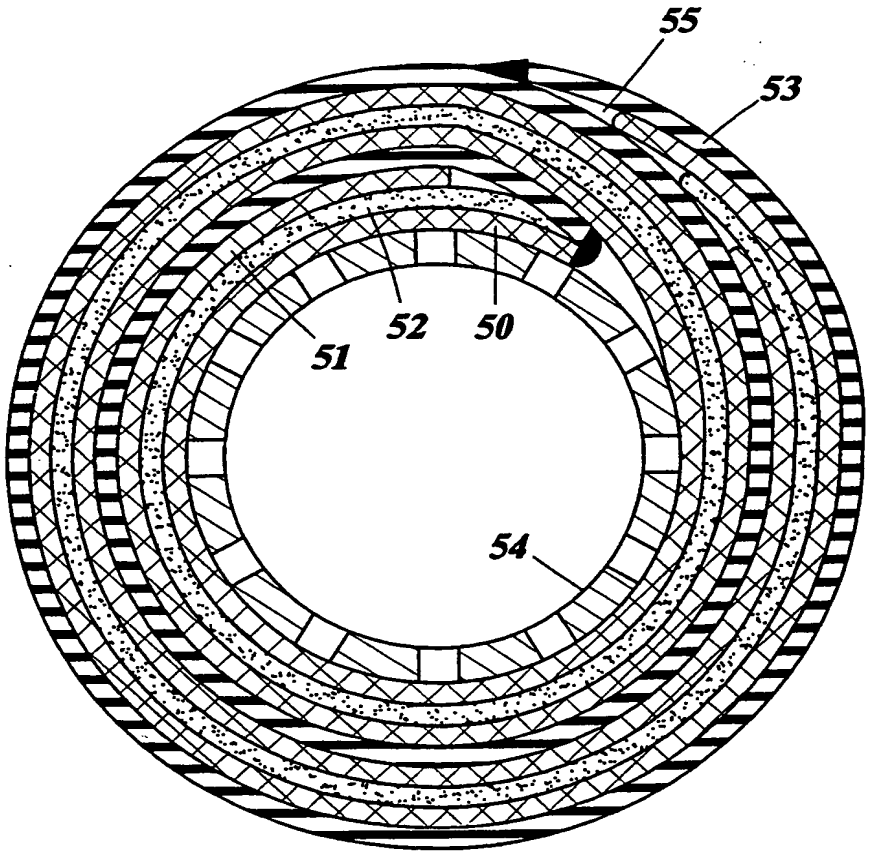

FIG. 5

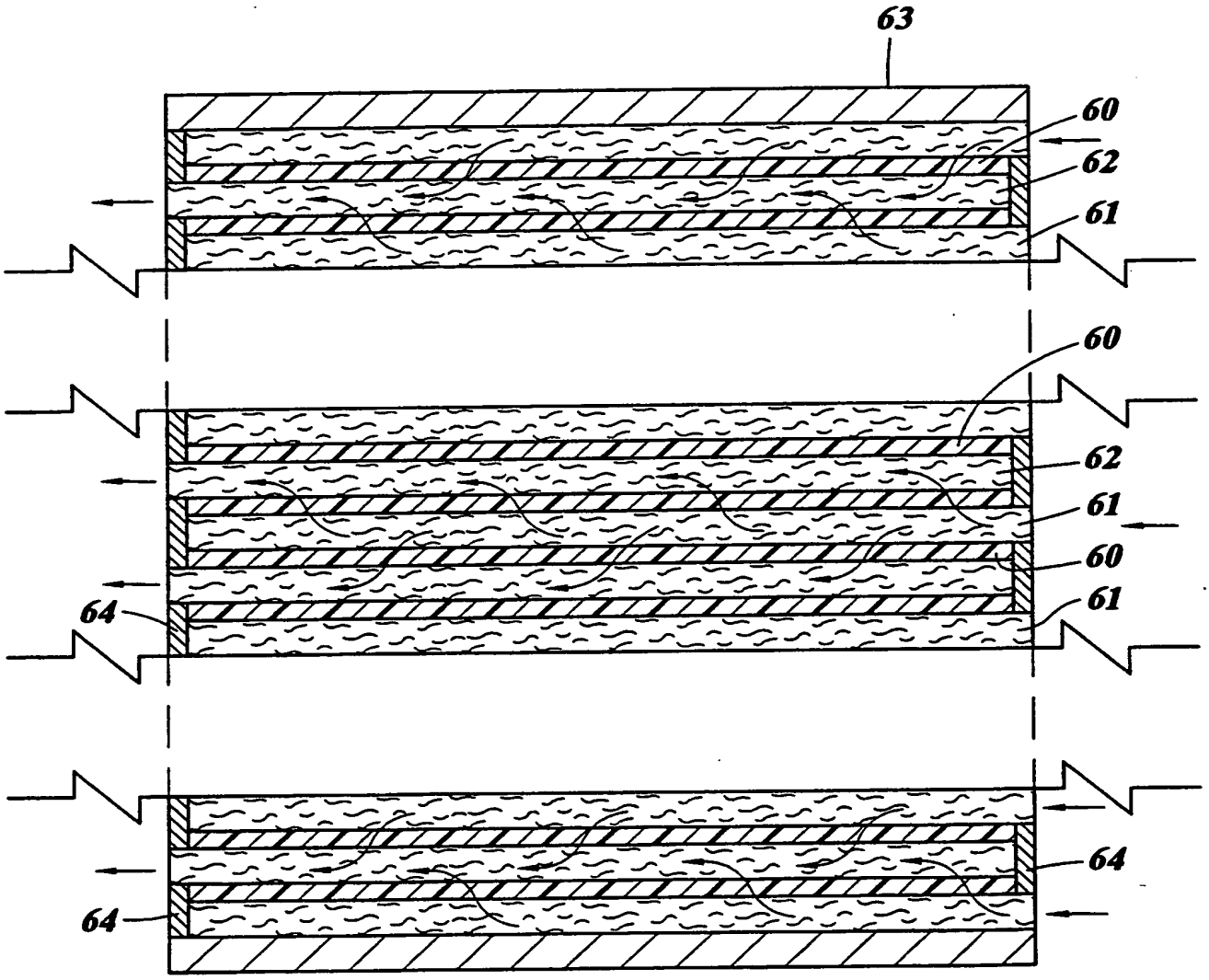

FIG. 6

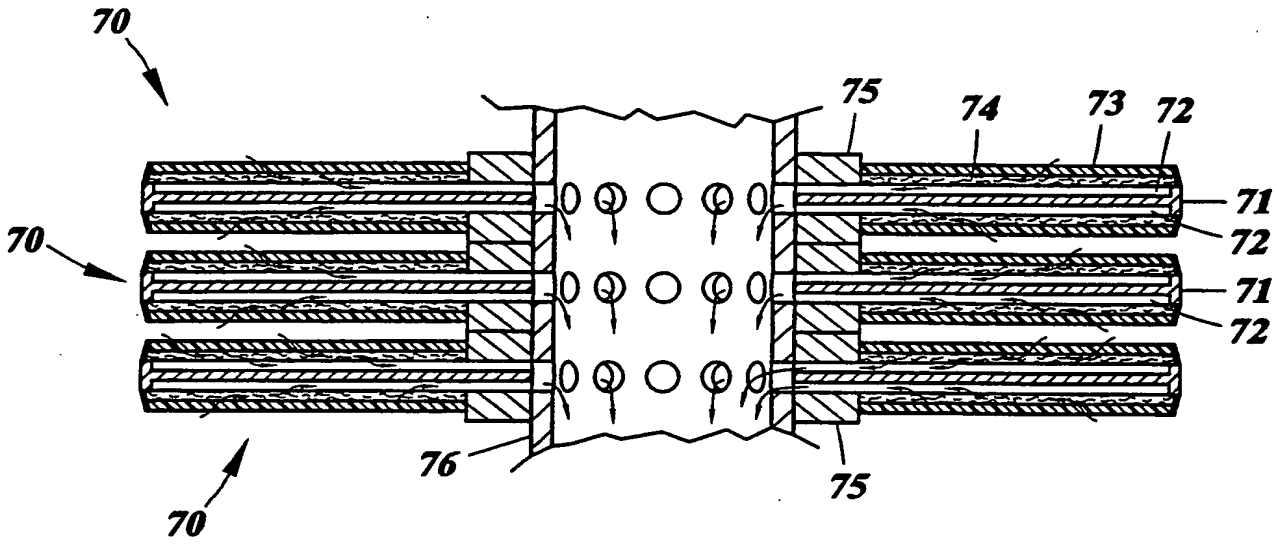

FIG. 7

INTERNATIONAL SEARCH REPORT

Internat l Application No
PCT/US 00/26112

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D29/23 B01D29/41 B01D29/01 B01D29/21

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 605 746 A (SERAD GEORGE A ET AL) 25 February 1997 (1997-02-25) abstract column 1, line 15 - line 27 column 2, line 8 - line 40 column 8, line 8 -column 9, line 16 column 10, line 13 - line 34 claims; figures	1,5-7, 18,20,21
Y		2,4, 8-10, 22-29

Y	US 5 543 047 A (STOYELL RICHARD C ET AL) 6 August 1996 (1996-08-06) cited in the application the whole document	2,4, 8-10, 22-29

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2001	21/02/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Hilt, D

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INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/US 00/26112

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 265 089 A (R.W. NUTTER) 1 March 1972 (1972-03-01) page 1, line 35 - line 50 page 2, line 82 -page 3, line 50 claims; figures 2,3	1,3,7,8
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Y	DE 42 17 159 A (SEITZ FILTER WERKE) 25 November 1993 (1993-11-25) abstract claims; figures	11,29
A	US 4 259 096 A (NAKAMURA YASUHIKO ET AL) 31 March 1981 (1981-03-31) abstract column 2, line 7 - line 16 column 3, line 18 - line 35 claim 1; figure 2	1,12,15, 18,22, 29,30
A	US 4 250 172 A (HAUSHEER HANS P ET AL) 10 February 1981 (1981-02-10) the whole document	1,6, 12-15, 18-23, 29-31

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna al Application No
PCT/US 00/26112

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5605746 A	25-02-1997	US 5486410 A	23-01-1996
		DE 69316027 D	05-02-1998
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What is claimed is:

1. A filter element comprising a pleated composite including a filter layer having first and second sides, and a first functional drainage layer disposed proximate the first side of the filter layer, the first functional drainage layer comprising a functional material and having a lower edgewise flow resistance than the filter layer.

2. A filter element as claimed in claim 1 wherein the composite has a plurality of pleats, each having first and second legs, the first leg contacting the second leg of the same pleat and the second leg of an adjacent pleat over a substantial portion of the height of the first leg.

3. A filter element as claimed in any preceding claim wherein the first functional drainage layer has an edgewise flow resistance at most approximately 50% that of the filter layer.

4. A filter element as claimed in any preceding claim wherein the first leg contacts the second leg of the same pleat and the second leg of an adjoining pleat over a substantially continuous region extending for a substantial portion of the height of the first leg and over at least fifty percent of an axial length of the filter element.

5. A filter element as claimed in any preceding claim wherein the pleated composite includes a second functional drainage layer disposed on the second side of the filter layer and comprising a functional material and having a lower edgewise flow resistance than the filter layer.

6. A filter element as claimed in any preceding claim wherein the first functional drainage layer comprises a porous fibrous sheet containing the functional material.

7. A filter element as claimed in any preceding claim wherein the first functional drainage layer contacts the filter layer.

8. A filter element as claimed in preceding claim wherein the filter element is

cylindrical.

9. A filter element as claimed in any preceding claim wherein a plurality of the pleats each have a radially outer end displaced in a circumferential direction of the filter element with respect to a radially inner end of the pleat.

10. A filter element as claimed in any preceding claim wherein the pleats are substantially parallel to each other.

11. A filter element comprising a composite of a filter layer and a fibrous sheet comprising a functional material and having a lower edgewise flow resistance than the filter layer, the composite being spirally wrapped around a hollow center of the filter element.

12. A filter element comprising:

a composite of first and second drainage layers and a filter layer disposed between the drainage layers, at least one of the drainage layers comprising a functional material, each drainage layer having a lower edgewise flow resistance than the filter layer, the composite being spirally wrapped around an axis.

13. A filter element as claimed in claim 12 wherein both drainage layers comprise a functional material.

14. A filter element as claimed in any preceding claim wherein a drainage layer comprises a fibrous sheet in which particles of the functional material are integrated.

15. A filter element comprising:

a support plate;

a filter layer disposed on the support plate; and

a drainage layer having a lower edgewise flow resistance than the filter layer disposed between the filter layer and the support plate and comprising a functional material.

16. A filter element as claimed in claim 15 wherein the support plate has an opening through which fluid can flow between opposite surfaces of the plate.

17. A filter element as claimed in claim 15 or 16 wherein the support plate is annular and an opening is at a radial center of the support plate.

18. A filter element comprising a plurality of filter layers, a plurality of first drainage layers, and a plurality of second drainage layers, each of the filter layers being sandwiched between one of the first drainage layers and one of the second drainage layers, each of the drainage layers having a lower edgewise flow resistance than the filter layers, a plurality of the drainage layers comprising a functional material.

19. A filter element as claimed in claim 18 wherein the first drainage layers are sealed off on an upstream side of the filter element and the second drainage layers are sealed off on a downstream side of the filter element.

20. A filter element as claimed in claim 18 or 19 wherein each of the drainage layers comprises a functional material.

21. A filter element as claimed in any of claims 18-20 wherein each of the filter layers and each of the drainage layers is substantially flat.

22. A method of treating a fluid comprising:

passing a fluid through a filter layer and edgewise through a functional drainage layer on a first side of the filter layer of a pleated filter composite to filter the fluid in the filter layer and treat the fluid with a functional material in the functional drainage layer.

23. A method as claimed in claim 22 including passing fluid through a second drainage layer disposed on a second side of the filter layer.

24. A method as claimed in claim 22 or 23 including passing the fluid in an axial direction of the filter element between opposite lengthwise ends thereof.

25. A method as claimed in claim 22 or 23 including passing the fluid primarily in an axial direction of the filter element through the first functional drainage layer.

26. A method as claimed in claim 22 or 23 including passing the fluid through the first functional drainage layer primarily along a height direction of the pleats.

27. A method as claimed in any of claims 22-26 wherein the filter element is cylindrical.

28. A method as claimed in any of claims 22-27 wherein the pleats are parallel to each other.

29. A method of treating a fluid comprising:

passing a fluid in an edgewise direction within a first drainage layer disposed on a first side of a filter layer, then passing the fluid through the filter layer to filter the fluid, and passing the fluid in an edgewise direction within a second drainage layer on a second side of the filter layer, at least one of the drainage layers containing a functional material which treats the fluid passing through it, each drainage layer having a lower edgewise flow resistance than the filter layer.

30. A method of treating a fluid comprising:

passing a fluid through a filter layer disposed on a support member to filter the fluid and through a functional drainage layer disposed between the filter layer and the support member and containing a functional material to treat the fluid with the functional material.

31. A method as claimed in claim 30 including passing the fluid through the filter layer before passing the fluid through the functional drainage layer.

32. A method as claimed in claim 30 Wherein the support member comprises an annular plate having an opening at a center thereof, the method including passing the fluid through the drainage layer in a radial direction of the plate.

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29 March 2001 (29.03.2001)

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(10) International Publication Number
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(51) International Patent Classification[7]: B01D 29/23, 29/41, 29/01, 29/21

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22 September 2000 (22.09.2000)

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(30) Priority Data:
60/155,138 22 September 1999 (22.09.1999) US

(71) Applicant *(for all designated States except US)*: **PALL CORPORATION** [US/US]; 2200 Northern Boulevard, East Hills, NY 11548-1209 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **WILLIAMSON, Kenneth, M.** [US/US]; 3139 Henneberry Road, Jamesville, NY 13078 (US). **MILLER, John, D.** [US/US]; 511 Kline Road, Ithaca, NY 14850 (US). **GEIBEL, Stephen, A.** [US/US]; 31 Prospect Terrace, Cortland, NY 13045 (US).

(74) Agent: **BELZ, John, M.**; Leydig, Voit & Mayer, Ltd., 700 Thirteenth Street, N.W., Suite 300, Washington, DC 20005 (US).

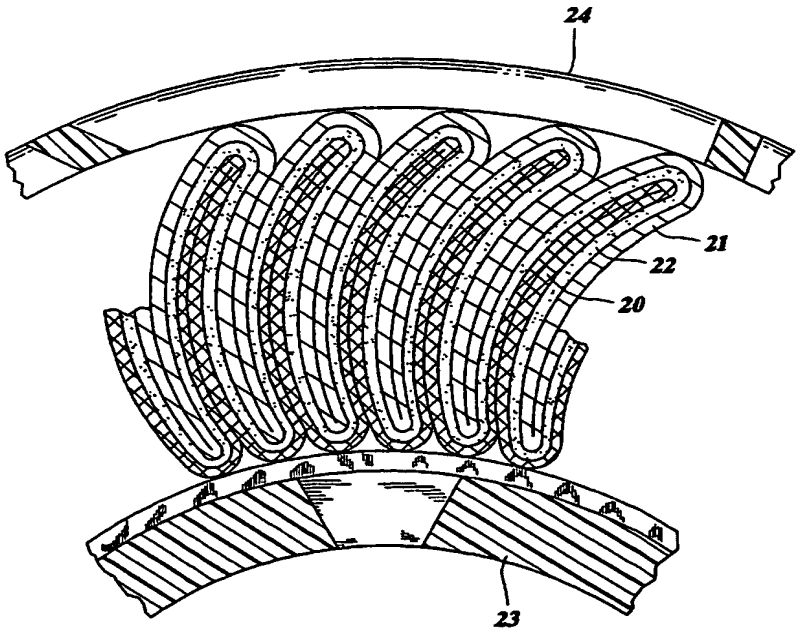
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

[Continued on next page]

(54) Title: FILTER ELEMENTS AND FILTERING METHODS



(57) Abstract: A filter element includes a filter layer and a functional drainage layer containing a functional material disposed on an upstream and/or a downstream side of the filter layer. The functional drainage layer can provide drainage for the filter layer as well as treat a fluid passing through it.

WO 01/21279 A1

— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

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INTERNATIONAL SEARCH REPORT

Internat .l Application No
PCT/US 00/26112

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D29/23 B01D29/41 B01D29/01 B01D29/21

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 605 746 A (SERAD GEORGE A ET AL) 25 February 1997 (1997-02-25) abstract column 1, line 15 - line 27 column 2, line 8 - line 40 column 8, line 8 -column 9, line 16 column 10, line 13 - line 34 claims; figures	1,5-7, 18,20,21
Y		2,4, 8-10, 22-29

Y	US 5 543 047 A (STOYELL RICHARD C ET AL) 6 August 1996 (1996-08-06) cited in the application the whole document	2,4, 8-10, 22-29

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Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2001	21/02/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hilt, D

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PCT/US 00/26112

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 265 089 A (R.W. NUTTER) 1 March 1972 (1972-03-01) page 1, line 35 - line 50 page 2, line 82 -page 3, line 50 claims; figures 2,3	1,3,7,8
Y		11,29
Y	DE 42 17 159 A (SEITZ FILTER WERKE) 25 November 1993 (1993-11-25) abstract claims; figures	11,29
A	US 4 259 096 A (NAKAMURA YASUHIKO ET AL) 31 March 1981 (1981-03-31) abstract column 2, line 7 - line 16 column 3, line 18 - line 35 claim 1; figure 2	1,12,15, 18,22, 29,30
A	US 4 250 172 A (HAUSHEER HANS P ET AL) 10 February 1981 (1981-02-10) the whole document	1,6, 12-15, 18-23, 29-31

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna... al Application No
PCT/US 00/26112

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5605746 A	25-02-1997	US 5486410 A	23-01-1996
		DE 69316027 D	05-02-1998
		DE 69316027 T	14-05-1998
		EP 0669993 A	06-09-1995
		EP 0825286 A	25-02-1998
		JP 2818693 B	30-10-1998
		JP 8503272 T	09-04-1996
		WO 9411556 A	26-05-1994
		US 5674339 A	07-10-1997
		US 6024813 A	15-02-2000
US 5543047 A	06-08-1996	US 6113784 A	05-09-2000
		US 5876601 A	02-03-1999
		US 5690765 A	25-11-1997
		US 5725784 A	10-03-1998
		DE 4395947 T	05-10-1995
		DE 69329118 D	31-08-2000
		DE 69329118 T	14-12-2000
		EP 0667800 A	23-08-1995
		GB 2288746 A,B	01-11-1995
		JP 8503412 T	16-04-1996
		CN 1091052 A	24-08-1994
		CN 1228347 A	15-09-1999
		CN 1228348 A	15-09-1999
		CN 1228349 A	15-09-1999
		EP 0982060 A	01-03-2000
		EP 0983954 A	08-03-2000
		EP 0982061 A	01-03-2000
		WO 9411082 A	26-05-1994
GB 1265089 A	01-03-1972	NONE	
DE 4217159 A	25-11-1993	NONE	
US 4259096 A	31-03-1981	JP 54098416 A	03-08-1979
US 4250172 A	10-02-1981	NONE	

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 440327/PALL	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US00/26112	International filing date *(day/month/year)* 22 September 2000 (22.09.2000)	Priority date *(day/month/year)* 22 September 1999 (22.09.1999)
International Patent Classification (IPC) or national classification and IPC IPC(7): B01D 27/06, 27/14 and US Cl.: 210/483, 488 - 491, 493.1, 493.5, 501, 502.1		
Applicant PALL CORPORATION		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☑ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
23 April 2001 (23.04.2001)	20 December 2001 (20.12.2001)
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Marianne Ocampo DEBORAH THOMAS PARALEGAL SPECIALIST Telephone No. (703) 308-0661

Form PCT/IPEA/409 (cover sheet)(July 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/26112

I. Basis of the report

1. With regard to the elements of the international application:*

☐ the international application as originally filed.

☒ the description:
pages 1-17 as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☒ the claims:
pages none , as originally filed
pages none , as amended (together with any statement) under Article 19
pages NONE , filed with the demand
pages 18-21 , filed with the letter of 28 September 2001 (28.09.2001)

☒ the drawings:
pages 1-7 , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☐ the sequence listing part of the description:
pages NONE , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages NONE

☐ the claims, Nos. NONE

☐ the drawings, sheets/~~fig~~ NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

V. Reasoned statement under Rule 66.2(a)(ii) with regard t novelty, inventive step or industrial applicability; citati ns and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims	2-5,9-10, 13, 15-17,19,23 and 25 -32	YES
	Claims	1, 6 -8, 11-12, 14, 18,20-22 and 24	NO
Inventive Step (IS)	Claims	3, 13, 15-17, 19 and 30-32	YES
	Claims	1-2, 4-10, 11-12, 14, 18 and 20-29	NO
Industrial Applicability (IA)	Claims	1-32	YES
	Claims	NONE	NO

2. CITATIONS AND EXPLANATIONS
Please See Continuation Sheet

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

V. 2. Citations and Explanations:
Claims 1, 6 - 8, 22, 24 and 27 lack novelty under PCT Article 33(2) as being anticipated by Muramatsu et al. (US 5,071,551).

With respect to claim 1, Muramatsu et al. disclose a filter element (7) comprising a pleated composite including a filter layer (7c) having first and second sides (outer and inner sides) and a first functional drainage layer in the form of a filter cloth/porous support applied with activated carbon powder disposed proximate the first side of the filter layer (7c), the first functional drainage layer comprising a functional material (activated carbon powder) and having an inherent lower edgewise flow resistance than the filter layer in order to let fluid flow therethrough and into the filter layer without much resistance/delay and due to its porous nature, as in col. 3, lines 4 - 10 and fig. 1.

With regards to claim 6, Muramatsu et al. also disclose the first functional drainage layer comprising a porous fibrous sheet (filter cloth) containing the functional material (activated carbon powder), as in col. 3, lines 8 - 10.

Regarding claim 7, Muramatsu et al. further disclose the first functional drainage layer (porous/filter cloth support) contacting the filter layer (7c), as in fig. 1 and col. 3.

Concerning claim 8, Muramatsu et al. also disclose the filter element is cylindrical, as in fig. 1 and col. 3, lines 4 - 10.

With regards to claim 22, Muramatsu et al. disclose a method of treating a fluid comprising passing a fluid through a filter layer (7c) and edgewise through the functional drainage layer (porous support) on a first/outer side of the filter layer (7c) of a pleated filter composite to filter the fluid in the filter layer and treat the fluid with a functional material (activated carbon) in the functional drainage layer, as in col. 3, lines 46 - 54.

Regarding claim 24, Muramatsu et al. further disclose the method including passing the fluid in an axial direction of the pleated filter composite (7) between opposite lengthwise ends thereof, as in fig. 1.

Concerning claim 27, Muramatsu et al. disclose the method wherein the pleated filter composite (7) comprising a cylindrical configuration, as in col. 3, lines 4 - 10.

Claims 1, 6 - 8, 11 - 12, 14, 18 and 20 - 21 lack novelty under PCT Article 33(2) as being anticipated by Groeger et al. (US 5,605,746).

With respect to claim 1, Groeger et al. disclose a filter element comprising a pleated composite including at least one filter layer (43 or 46 or 48 - 49) having first and second sides and a first functional drainage layer (44 or 45 or 47) disposed proximate the first (top or bottom) side of the filter layer and the functional drainage layer comprising a functional material (activated carbon, silica, zeolite,

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

molecular sieves, clay, alumina, etc). and has a lower edgewise flow resistance than the filter layer, as in cols. 5 - 10 and fig. 3. The drainage layer (44 or 45 or 47) has an inherent lower edgewise flow resistance than the filter layer due to the density of the fibers allowing fluid to pass easily through the drainage layer than through the filter layer, as in fig. 3.

Regarding claim 6, Groeger et al. also disclose the first functional drainage layer (44 or 45 or 47) comprising a porous fibrous sheet containing the functional material (activated carbon, etc), as in cols 8 - 9.

With regards to claim 7, Groeger et al. further disclose the first functional drainage layer contacting the filter layer (43 or 46 or 48-49), as in fig. 3.

Concerning claim 8, Groeger et al. also disclose the filter element is cylindrical (tubes or tubular form), as in col. 10, lines 29 - 31.

With respect to claim 11, Groeger et al. disclose a filter element comprising a composite of a filter layer and a fibrous sheet comprising a functional material (mentioned in claim 1 above) having a lower edgewise flow resistance than the filter layer, the composite being spirally wrapped around a hollow center of the filter element, as in the formation of a fibrous tubular roll, as in cols. 10 - 11.

Regarding claim 12, Groeger et al. disclose a filter element comprising a composite of first and second drainage layers (45 and 47) and a filter layer (46) disposed between the first and second drainage layers, and at least one of the drainage layers comprising a functional material (mentioned in claim 1 above) and each layer having a lower edgewise flow resistance than the filter layer, the composite being spirally wrapped around a n axis (usually central axis or hollow center) of the filter element, as in the formation of a fibrous tubular roll, as in cols. 8 - 11 and fig. 3.

With regards to claim 14, Groeger et al. also disclose the drainage layers comprising fibrous sheets in which particles (such as activated carbon, and other particulates such as zeolites, silica, clay, etc) of the functional material are integrated, as in fig. 3 and in cols. 5 - 11.

Concerning claim 18, Groeger et al. disclose a filter element comprising a plurality of filter layers (at least 2 are shown) and a plurality of first drainage layers (at least 2 are shown) and second drainage layers (one is shown), each of the filter layers being sandwiched between one of the first and second drainage layers and the drainage layers having lower edgewise flow resistance than the filter layers, and the drainage layers comprising functional material, as in fig. 3.

With respect to claim 20, Groeger et al. further disclose the drainage layers comprising a functional material, as in cols. 5 - 10.

Regarding claim 21, Groeger et al. disclose each of the filter layers and drainage layers is substantially flat, as in fig. 3.

Claims 1, 2, 4 - 10 and 22 - 29 lack an inventive step under PCT Article 33(3) as being obvious over Stoyell et al. (US 5,543,047) in view of Groeger et al. (746).

Concerning claim 1, Stoyell et al. disclose a filter element (10) comprising a pleated composite including a filter layer (12) having first and second sides, and a first drainage layer (13 or 14) proximate the first side of the filter layer (12) and having a lower edgewise flow resistance than the filter layer, as in figs. 1 & 4 and col. 5. However, Stoyell et al. fail to disclose the drainage layer being a functional drainage layer comprising a functional material. Groeger et al. teach a filter element (42) comprising a pleated composite including a filter layer (46, 48) and a first functional drainage layer (45) comprising a functional material (50) proximate its outer/first side of the filter layer (46). It is considered obvious to one of ordinary skill in the art at the time of the invention to modify the filter element of Stoyell et al. by substituting the first drainage layer (13 or 14) of the filter element in lieu of the functional drainage layer taught by Groeger et al. in order to provide an improved filter element having the ability not only to effectively filter fluids but is also able to remove other undesirable contaminants of the fluid such as residual chlorine and other impurities such as mildew, mildew odors and even microorganisms including bacteria and viruses, particularly if the fluid being treated is water, thereby giving a cleaner and safer fluid/water for consumption.

With regards to claim 2, Stoyell et al. further disclose the composite having a plurality of pleats (11) each having first and second legs (11a), the first leg contacting the second leg of the same pleat (11) and the second leg of an adjacent pleat over a substantial portion of the height of the first leg, as in fig. 2.

Regarding claim 4, Stoyell et al. also disclose the first leg contacting the second leg of the same pleat and the second leg of an adjacent pleat over a substantially continuous region extending for a substantial portion of the height of the first leg and over at least fifty percent of an axial length of the filter element (10), as in fig. 1.

With respect to claim 5, Stoyell et al. disclose the pleated filter element (10) further including a second drainage layer (14) disposed

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

on a second side of the filter layer (12) and also having a lower edgewise flow resistance than the filter layer (12), as in col. 5 and fig. 4. However Stoyell et al. fail to disclose the second drainage layer being a functional drainage layer comprising a functional material. Groeger et al. teach the filter element (42) which can formed into a pleated composite, including a second drainage layer (47) having a functional material (54) on a second side of the filter layer (46), as in fig. 3. It is considered obvious to one of ordinary skill in the art at the time of the invention to modify the filter element of Stoyell et al. by having the second drainage layer also having functional material as taught by Groeger et al., in order to provide a more improved and more effective filter element having the means to further treat the fluid after filtration thereof by other than removal of impurities which may be suspended in the fluid, but also removal of other contaminants such as microorganisms which may not have been removed by the first functional material in the first drainage layer and the filter layer, thereby providing a cleaner, safer and healthier fluid/water for use/consumption.

Concerning claim 6, Stoyell et al., as modified by Groeger et al. teach the first functional drainage layer (45) comprising a porous fibrous sheet containing functional material (50), as in fig. 3 and col. 9.

With regards to claim 7, , Stoyell et al., as modified by Groeger et al. teach the first functional drainage layer (45) contacting the filter layer (46), as in fig. 3.

Regarding claim 8, Stoyell et al. disclose the filter element is cylindrical, as in fig. 1.

With respect to claim 9, Stoyell et al. further disclose the plurality of pleats (11) each have a radially outer end (11b) disposed in a circumferential direction of the filter element (10) with respect to a radially inner end (11c) of the pleat, as in fig. 3.

Concerning claim 10, Stoyell et al. also disclose the pleats (11) are substantially parallel to each other, as in figs. 1, 3 and 4.

With regards to claim 22, Stoyell et al. disclose a method of treating a fluid comprising passing a fluid through a filter layer (12) and edgewise through a drainage layer (13) on a first side of a pleated filter composite (10) to filter the fluid in the filter layer, as in cols. 5 - 6. However, Stoyell et al. fail to teach the drainage layer being a functional drainage layer containing functional material which treat the fluid as it passes therethrough. Groeger et al. teach a method of treating a fluid including passing the fluid through a filter layer (46) and through a drainage layer (45) which is a functional drainage layer with functional material (50) for treating the fluid thereby removing chlorine or other impurities in the fluid prior to passing through the filter layer (46). It is considered obvious to one of ordinary skill in the art at the time of the invention to modify the method of filtering of Stoyell et al, by substituting the drainage layer in lieu of the functional drainage layer taught by Groeger et al., in order to provide an improved method of filtering fluids, thereby providing additional treatment of fluids, making the fluids safer or cleaner for use/consumption.

Regarding claim 23, Stoyell et al. further disclose passing the fluid through a second drainage layer (14) disposed on a second side of the filter layer (12), as in col. 5.

With respect to claim 24, Stoyell et al. also disclose passing the fluid in an axial direction of the pleated filter (10) between opposite lengthwise ends thereof, as in cols. 5 - 6.

Concerning claim 25, Stoyell et al. as modified by Groeger et al. teach passing the fluid primarily in an axial direction of the filter element (10) through the first functional drainage layer (13), as in col. 5, lines 44 - 47.

With regards to claim 26, Stoyell et al. as modified by Groeger et al. teach passing the fluid through the first drainage layer primarily along a height direction of the pleats (11), as in col. 5.

Regarding claim 27, Stoyell et al. disclose the filter element (10) comprising a cylindrical configuration, as in fig. 1.

With respect to claim 28, Stoyell et al. disclose the pleats (11) being parallel to each other, as in figs. 1 - 3.

Lastly in regards to claim 29, Stoyell et al., disclose a method of filtering a fluid comprising passing a fluid in an edgewise direction within a first drainage layer (13) disposed on a first side of the filter layer (12) and passing the fluid through the filter layer (12) and passing the fluid in an edgewise direction through a second drainage layer (14) on a second side of the filter layer (12), and the drainage layers having a lower edgewise flow resistance than the filter layer (12), as in col. 5, but fail to disclose at least one of the drainage layers containing a functional material which treats the fluid passing therethrough. Groeger et al. teach a method of treating a fluid including passing the fluid through a filter layer (46) and through a drainage layer (45) which is a functional drainage layer with functional material (50) for treating the fluid thereby removing chlorine or other impurities in the fluid prior to passing through the filter layer (46). It is considered obvious to one of ordinary skill in the art at the time of the invention to modify the method of filtering of Stoyell et al, by substituting the drainage layer in lieu of the functional drainage layer taught by Groeger et al., in order to provide an improved method of filtering fluids, thereby providing additional treatment of fluids, making the fluids safer or cleaner for use/consumption.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Claims 3, 13, 15 - 17, 19 and 30 - 32 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest a filter element having the limitation of the first functional drainage layer having an edgewise flow resistance at most approximately 50% that of the filter layer, as in claim 3, and the limitation of having both drainage layers comprising functional material, as in claim 13, and the limitations of filter element comprising a support plate, a filter layer disposed on the support plate and a drainage layer comprising functional material disposed between the filter layer and the support plate, as in claim 15, and a filter element having the limitation of the first drainage layers being sealed off on an upstream side of the filter element and the second drainage layers being sealed off on a downstream side of the element, as in claim 19, and lastly, a method comprising the steps recited in claim 30.

Claims 1 - 32 have industrial applicability in the field of fluid filtration.

---------- NEW CITATIONS ----------

US 5,543,047 A (STOYELL et al.) 06 August 1996, see cols. 5 - 6 & figs. 1 & 4.

US 5,071,551 A (MURAMATSU et al.) 10 December 1991, see col. 3 and fig. 1.

US 5,038,775 A (MARUSCAK et al.) 13 August 1991, see cols. 4 - 5 and figs. 3 - 4.

US 4,206,050 A (WALCH et al.) 03 June 1980, see cols. 4 - 6 & figs. 1 - 2.

US 5,720,878 A (BOLYARD) 24 February 1998, see cols. 3 - 5 & fig. 1.

US 3,948,778 A (MULLER) 06 April 1976, see col. 4 and figs. 1a and 3.

US 3,647,084 A (MARTIN) 07 March 1972, see cols. 2 - 4 and figs. 1 - 3.

US 5,389,256 A (MCEWEN et al.) 14 February 1995, see col. 6 and fig. 11.

US 4,816,150 A (PIERRARD et al.) 28 March 1989, see cols. 3 - 4 and fig. 3.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
JOHN M. BELZ
LEYDIG, VOIT & MAYER, LTD.
700 13TH STREET, N.W.
SUITE 300
WASHINGTON, DC 20005

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of Mailing *(day/month/year)*	05 SEP 2001
Applicant's or agent's file reference 440327/PALL	REPLY DUE within 1 months/days from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US00/26112	22 September 2000 (22.09.2000)	22 September 1999 (22.09.1999)

International Patent Classification (IPC) or both national classification and IPC

IPC(7): B01D 27/06, 27/14 and US Cl.: 210/483, 488 - 491, 493.1, 493.5, 501, 502.1

Applicant

PALL CORPORATION

1. This written opinion is the first (first, etc,) drawn by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2 (a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. ~~The applicant may, before the expiration of that time limit, request this Authority to grant an extension. See rule 66.2(d).~~

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 *bis*.
For an informal communication with the examiner, see Rule 66.6

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 22 January 2003 (22.01.2003)

Name and mailing address of the IPEA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Marianne Ocampo
Facsimile No. (703)305-3230	Telephone No. (703) 308-0661

DEBORAH THOMAS
PARALEGAL SPECIALIST

Form PCT/IPEA/408 (cover sheet)(July 1998)

WRITTEN OPINION

International application No.
PCT/US00/26112

I. Basis of the opinion

1. With regard to the elements of the international application:*

☒ the international application as originally filed

☒ the description:
pages 1-17, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

☒ the claims:
pages 18-21, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

☒ the drawings:
pages 1-7, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

☐ the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages NONE

☐ the claims, Nos. NONE

☐ the drawings, sheets/~~fig~~ NONE

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed."*

WRITTEN OPINION

International application No.
PCT/US00/26112

III. Non-establishment of opini n with regard to novelty, inventive step and industrial applicability

1. The question whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos. Claims 4-10,14,21 and 27-28 were not examined.

because:

☐ the said international application, or the said claim Nos. _____ relate to the following subject matter which does not require international preliminary examination *(specify)*:

☒ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. 4-10,14,21,27 and 28 are so unclear that no meaningful opinion could be formed *(specify)*:

Claims 4-10, 14, 21 and 27 - 28 are improper multiple dependent claims under PCT Rule 6.4 (a).

☐ the claims, or said claims Nos. _____ are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for said claims Nos. _____.

2. A written opinion cannot be drawn due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

WRITTEN OPINION

International application No.
PCT/US00/26112

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims 22-26 and 29	YES
	Claims 1-3, 11-13,15-20 and 30-32	NO
Inventive Step (IS)	Claims 22-26 and 29	YES
	Claims 1-3, 11-13, 15-20 and 30-32	NO
Industrial Applicability (IA)	Claims 1-3, 11-13, 15-20, 22-26 and 29-32	YES
	Claims NONE	NO

2. CITATIONS AND EXPLANATIONS
Please See Continuation Sheet

Claims 22 - 26 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest a method of treating a fluid comprising all the steps recited in the independent claim 22, and in particular the step of passing the fluid edgewise through a functional drainage layer on a first side of the filter layer of a pleated filter composite.

Claim 29 meets the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest a method of treating a fluid comprising all the steps recited in the independent claim 29, and in particular the step of passing a fluid in an edgewise direction within a first drainage layer disposed on a first side of the filter layer and then passing the fluid through the filter layer and passing the fluid in an edgewise direction within a second drainage layer on a second side of the filter layer.

Claims 1 - 3, 11 - 13, 15 - 20, 22 - 26 and 29 - 32 have industrial applicability in the field of fluid filtration or purification.

---------- NEW CITATIONS ----------

US 5,038,775 A (MARUSCAK et al.) 13 August 1991, see cols. 4 - 5 & figs. 3 - 4.

US 4,206,050 A (WALCH et al.) 03 June 1980, see cols. 4 - 6 & fig. 1 - 2.

US 5,720,878 A (BOYARD) 24 February 1998, see cols. 3 - 5 and fig. 1.

US 3,948,778 A (MULLER) 06 April 1976, see col. 4 and figs. 1a and 3.

US 3,647,084 A (MARTIN) 07 March 1972, see cols. 2 - 4 and figs. 1 - 3.

US 5,389,256 A (MCEWEN et al.) 14 February 1995, see col. 6 and fig. 11.

US 4,816,150 A (PIERRARD et al.) 28 March 1989, see cols. 3 - 4 and fig. 3.

WRITTEN OPINION

International application No.
PCT/US00/26112

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

The word "wherein" should all be in lower case letters, after the number "30" in the first line of claim 32.

The abstract would have to rewritten in order to include reference characters of the following structural elements of the invention: the filter layer (12) and functional drainage layer (10, 11).

WRITTEN OPINION

International application No.
PCT/US00/26112

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the questions whether the claims are fully supported by the description, are made:

Claims 4 - 10, 14, 21 and 27-28 are objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because claims are indefinite for the following reason(s):

The claims are improper multiple dependent claims. Multiple dependent claims should only refer to other previous claims in the alternative only. Since it is not clearl which of the limitations set forth in the other claims are being claimed by the improper multiple dependent claims, they are considered indefinite.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

TIME LIMIT:
The time limit set for response to a Written Opinion may not be extended. 37 CFR 1.484(d). Any response received after the expiration of the time limit set in the Written Opinion will not be considered in preparing the International Preliminary Examination Report.

V. 2. Citations and Explanations:
Please See Continuation Sheet

Claims 1 - 3 and 12 - 13 lack novelty under PCT Article 33(2) as being anticipated by Maruscak et al. (US 5,038,775).

With respect to claim 1, Maruscak et al. disclose a filter element (1) comprising a pleated composite including at least one filter layer (3) having first and second sides, and a first functional drainage layer (5) disposed proximate the first side (either top or bottom side) the filter layer and the functional drainage layer comprising a functional material (such as material which makes the drainage/scrim layer inert to fungi, molds, microorganisms and chemical reagents) and has a lower edgewise flow resistance than the filter layer, as in fig. 3 and cols. 2 - 6.

Regarding claim 2, Maruscak et al. disclose the composite (1) having a plurality of pleats, each having first and second legs, the first leg contacting the second leg of the same pleat and the second leg of and adjcent pleat over a substantial portion of the height of the first leg, as in figs. 3 - 4.

Concerning claim 3, Maruscak et al. disclose the first functional drainage layer (5) having an edgewise flow resistance at most approximately 50% that of the filter layer, as in fig. 3. It is considered inherent of porous drainage layers such as the one depicted in fig. 3, which has larger openings than that of the filter layer, that the edgewise flow resistance thereof could be approximately 50% or less, in order to let fluid flow therethrough and into the filter layer adjacent thereto.

With regards to claim 12, Maruscak et al. disclose a filter element comprising a composite of a filter layer (3) and first and second drainage layers (5), with the filter layer (3) disposed therebetween, and the drainage layers (5), as already mentioned in claim 1 above, comprising functional materials and has lower edgewise flow resistance and the composite being spirally wrapped (rolled) around an axis, as in fig. 3 and example 1.

Concerning claim 13, Maruscak et al. disclose both drainage layers comprising functional materials, as in col. 4.

Claim 11 lacks novelty under PCT Article 33(2) as being anticipated by Walch et al. (US 4,206,050).

With respect to claim 11, Walch et al. disclose a filter element comprising a composite of a filter layer (1) and a fibrous sheet (2,3) comprising functional material and having a lower edgewise flow resistance than the filter layer (1) and the composite being spirally wrapped around a hollow center of the filter element, as in figs. 1 and 3 and cols. 5 - 6.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Claims 15 - 17 and 30 - 32 lack an inventive step under PCT Article 33(3) as being obvious over Muller (778) in view of Bolyard (878).

.With respect to claim 15, Muller discloses a filter element (1) comprising a support plate (4), a filter layer (2) disposed on the support plate (4) and a drainage/intermediate layer (3) in the form of a wire mesh or the like which inherently has a lower edgewise flow resistance than the filter layer and disposed between the filter layer (2) and the support layer (4), as in fig. 1a and 3 and col. 4. However, Muller fails to disclose the drainage layer (3) comprising a functional material. Bolyard (878) teaches a filter element (10) having drainage or intermediate layers (26, 28, 30 - 36) having lower edgewise flow resistance than its filter layers (18 - 24), wherein at least some of the drainage/intermediate layers (26, 28) adjacent to some of the filter layers (22, 24) comprising functional materials, such as ion exchange particles or carbon particles such as zeolites, as in cols. 3 - 4 and fig. 1. It is considered an obvious modification to one of ordinary skill in the art to modify the drainage layer of the filter element of Muller, by substituting it with one of the drainage layers comprising a functional material taught by Bolyard, in order to provide an improved filter element having means to further treat a fluid (liquid or gas) after or before filtration by the filter layer, thereby providing a cleaner fluid. In this case, the further treatment is either the removal of charged particles or specific ions which are considered contaminants or undesirable in the final/filtered fluid.

Regarding claim 16, Muller further discloses the support plate (4) having an opening through which fluid can flow between opposite surfaces of the plate, as in col. 4 and figs. 1a and 3.

Concerning claim 17, Muller also discloses the support plate (4) is annular and has an opening at a radial center of the plate (near the location of shaft 5), as in col. 4 and fig. 3.

With respect to claim 30, Muller discloses a method of treating a fluid comprising passing a fluid through a filter layer (2) and through the drainage layer (3) disposed between the filter layer (2) and the support plate (4). Muller, as modified by Bolyard above, would obviously make the drainage layer of Muller into a functional drainage layer, and thus, would be containing the functional material to treat the fluid therewith, as in fig. 3.

Concerning claim 31, Muller also discloses the method including passing the fluid through the filter layer (2) before passing through the drainage layer (3), as also in fig. 3.

Regarding claim 32, Muller discloses the method including passing the fluid through the drainage layer in a radial direction of the support plate (4), as in fig. 3.

Claims 15 - 17 and 30 - 32lack an inventive step under PCT Article 33(3) as being obvious over Muller (778) in view of Nutter et al. (089).

.With respect to claim 15, Muller discloses a filter element (1) comprising a support plate (4), a filter layer (2) disposed on the support plate (4) and a drainage/intermediate layer (3) in the form of a wire mesh or the like which inherently has a lower edgewise flow resistance than the filter layer and disposed between the filter layer (2) and the support layer (4), as in fig. 1a and 3 and col. 4. However, Muller fails to disclose the drainage layer (3) comprising a functional material. Nutter et al. (089) teach a filter element comprising a filter layer (64) and at least one drainage layer (62) which comprised a functional material, as in page 2 and fig. 3. It is considered an obvious modification to one of ordinary skill in the art to modify the drainage layer of the filter element of Muller, by substituting it with the drainage layer comprising a functional material taught by Nutter et al., in order to provide an improved filter element having means to further treat a fluid (liquid or gas) after or before filtration by the filter layer, thereby providing a cleaner fluid. In this case, the further treatment is the removal of unwanted hydrocarbons which are considered contaminants or undesirable in the final/filtered fluid.

Regarding claim 16, Muller further discloses the support plate (4) having an opening through which fluid can flow between opposite surfaces of the plate, as in col. 4 and figs. 1a and 3.

Concerning claim 17, Muller also discloses the support plate (4) is annular and has an opening at a radial center of the plate (near the location of shaft 5), as in col. 4 and fig. 3.

With respect to claim 30, Muller discloses a method of treating a fluid comprising passing a fluid through a filter layer (2) and through the drainage layer (3) disposed between the filter layer (2) and the support plate (4). Muller, as modified by Nutter et al. above, would obviously make the drainage layer of Muller into a functional drainage layer, and thus, would be containing the functional material to treat the fluid therewith, as in fig. 3.

Concerning claim 31, Muller also discloses the method including passing the fluid through the filter layer (2) before passing through

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

the drainage layer (3), as also in fig. 3.

Regarding claim 32, Muller discloses the method including passing the fluid through the drainage layer in a radial direction of the support plate (4), as in fig. 3.

Claims 15 - 17 and 30 - 32 lack an inventive step under PCT Article 33(3) as being obvious over Martin (084) in view of Bolyard (878).

.With respect to claim 15, Martin discloses a filter element comprising a support plate (24, 38), a filter layer (10) disposed on the support plate (24, 38) and a drainage layer (22, 34) in the form of a perforated ring plate which inherently has a lower edgewise flow resistance than the filter layer and disposed between the filter layer (10) and the support layer (24, 38), as in figs. 2 - 3 and cols. 2 - 3. However, Martin fails to disclose the drainage layer (22, 34) comprising a functional material. Bolyard (878) teaches a filter element (10) having drainage or intermediate layers (26, 28, 30 - 36) having lower edgewise flow resistance than its filter layers (18 - 24), wherein at least some of the drainage/intermediate layers (26, 28) adjacent to some of the filter layers (22, 24) comprising functional materials, such as ion exchange particles or carbon particles such as zeolites, as in cols. 3 - 4 and fig. 1. It is considered an obvious modification to one of ordinary skill in the art to modify the drainage layer of the filter element of Martin, by substituting it with one of the drainage layers comprising a functional material taught by Bolyard, in order to provide an improved filter element having means to further treat a fluid (like oil or gas) after or before filtration by the filter layer, thereby providing a cleaner fluid/oil. In this case, the further treatment is either the removal of charged particles or specific ions which are considered contaminants or undesirable in the final/filtered fluid/oil.

Regarding claim 16, Martin further discloses the support plate (24, 38) having an opening through which fluid can flow between opposite surfaces of the plate, as in cols. 2 - 3 and figs. 2 - 3.

Concerning claim 17, Martin also discloses the support plate (24, 38) is annular and has an opening at a radial center of the plate, as in figs. 2 - 3.

With respect to claim 30, Martin discloses a method of treating a fluid comprising passing a fluid through a filter layer (10) and through the drainage layer (22) disposed between the filter layer (10) and the support plate (38). Muller, as modified by Bolyard above, would obviously make the drainage layer of Martin into a functional drainage layer, and thus, would be containing the functional material to treat the fluid therewith, as in figs. 1a - 3 and cols. 1 - 2.

Concerning claim 31, Martin also discloses the method including passing the fluid through the filter layer (10) before passing through the drainage layer (22), as also in cols. 1 - 2.

Regarding claim 32, Martin discloses the method including passing the fluid through the drainage layer in a radial direction of the support plate (38), as in cols. 1 - 2.

Claims 15 - 17 lack an inventive step under PCT Article 33(3) as being obvious over McEwen et al. (256) in view of Bolyard (878).

.With respect to claim 15, McEwen et al. disclose a filter element (88) comprising a support plate (110), a filter layer (114) disposed on the support plate (110) and a drainage/backing layer (112) in the form of a woven mesh which inherently has a lower edgewise flow resistance than the filter layer and disposed between the filter layer (114) and the support layer (110), as in fig. 11 and col. 6. However, McEwen et al. fail to disclose the drainage layer (112) comprising a functional material. Bolyard (878) teaches a filter element (10) having drainage or intermediate layers (26, 28, 30 - 36) having lower edgewise flow resistance than its filter layers (18 - 24), wherein at least some of the drainage/intermediate layers (26, 28) adjacent to some of the filter layers (22, 24) comprising functional materials, such as ion exchange particles or carbon particles such as zeolites, as in cols. 3 - 4 and fig. 1. It is considered an obvious modification to one of ordinary skill in the art to modify the drainage layer of the filter element of McEwen et al., by substituting it with one of the drainage layers comprising a functional material taught by Bolyard, in order to provide an improved filter element having means to further treat a fluid (like coolant or gas) after or before filtration by the filter layer, thereby providing a cleaner fluid/coolant. In this case, the further treatment is either the removal of charged particles or specific ions which are considered contaminants or undesirable in the final/filtered fluid/ coolant.

Regarding claim 16, McEwen et al. further discloses the support plate (110) having an opening through which fluid can flow between opposite surfaces of the plate, as in fig. 11.

Concerning claim 17, Martin also discloses the support plate (110) is annular and has also an opening at a radial center of the plate, as in fig. 11.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Claims 18 - 20 lack novelty under PCT Article 33(2) as being anticipated by Pierrard et al. (150).

With respect to claim 18, Pierrard et al. disclose a filter element comprising a plurality of filter layers (1), a plurality of first (top or bottom, 2) drainage layers and a plurality of second drainage layers (2, bottom or top, with respect to the filter layer and direction of filtration) wherein each of the filter layers (1) is sandwiched between one of the first and one of the second drainage layers (2) and the drainage layers (2) having a lower edgewise flow resistance than the filter layers (1) and comprising a functional material, such as carbon or any suitable/appropriate material, as in col. 3 and fig. 3.

Concerning claim 19, Pierrard et al. also disclose the drainage layers (both first and second) being sealed off on an upstream and downstream sides, respectively of the filter element, as in fig. 3.

Regarding claim 20, Pierrard et al. disclose each of the drainage layers (2) comprising a functional material (carbon), as in col. 3.

Claims 1, 11 - 12, 18 and 20 lack novelty under PCT Article 33(2) as being anticipated by Groeger et al. (US 5,605,746).

With respect to claim 1, Groeger et al. disclose a filter element comprising a pleated composite including at least one filter layer (43, 46, 48 -49) having first and second sides, and a first functional drainage layer (44, 45, 47, respectively) disposed proximate the first side (either top or bottom side) the filter layer and the functional drainage layer comprising a functional material and has a lower edgewise flow resistance than the filter layer, as in fig. 3 and cols. 5 - 10.

Concerning claim 11, Groeger et al. disclose a filter element comprising at least one filter layer (43, 46, 48-49) and a fibrous sheet (44, 45, 47) comprising functional material and having a lower edgewise flow resistance than the filter layer (43, 46, 48-49) and the composite being spirally wrapped around a hollow center of the filter element (forming a filter tube or roll), as in cols. 5 -10.

Regarding claim 12, Groeger et al. disclose a filter element comprising a composite of first and second drainage layers (45, 47, respectively) and a filter layer(46) disposed therebetween, at least one of the drainage layers comprising a functional material and having a lower edgewise flow resistance than the filter layer (46) and the composite being spirally wrapped around an axis (forming a filter tube or roll), as in cols. 5 -10.

With regards to claim 18, Groeger et al. disclose a filter element a plurality of filter layers (43, 46, 48- 49), a plurality of first (top or bottom, 44, 45) drainage layers and a plurality of second drainage layers (45, 47 bottom or top, with respect to the filter layer and direction of filtration) wherein the filter layer is sandwiched between one of the first and one of the second drainage layers and the drainage layers having a lower edgewise flow resistance than the filter layers (1) and comprising a functional material, as in cols. 5 - 10.

Concerning claim 20, Groeger et al. disclose each of the drainage layers comprising functional material, as in cols. 5 - 10.

---------- NEW CITATIONS ----------

US 5,038,775 A (MARUSCAK et al.) 13 August 1991, see cols. 4 - 5 & figs. 3 - 4.

US 4,206,050 A (WALCH et al.) 03 June 1980, see cols. 4 - 6 & fig. 1 - 2.

US 5,720,878 A (BOYARD) 24 February 1998, see cols. 3 - 5 and fig. 1.

US 3,948,778 A (MULLER) 06 April 1976, see col. 4 and figs. 1a and 3.

US 3,647,084 A (MARTIN) 07 March 1972, see cols. 2 - 4 and figs. 1 - 3.

US 5,389,256 A (MCEWEN et al.) 14 February 1995, see col. 6 and fig. 11.

US 4,816,150 A (PIERRARD et al.) 28 March 1989, see cols. 3 - 4 and fig. 3.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
JOHN M. BELZ
LEYDIG, VOIT & MAYER, LTD.
700 13TH STREET, N.W.
SUITE 300
WASHINGTON, DC 20005

PCT

WRITTEN OPINION

(PCT Rule 66)

Applicant's or agent's file reference 440327/PALL	Date of Mailing *(day/month/year)* REPLY DUE within 1 months/days from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US00/26112	22 September 2000 (22.09.2000)	22 September 1999 (22.09.1999)

International Patent Classification (IPC) or both national classification and IPC

IPC(7): B01D 27/06, 27/14 and US Cl.: 210/483, 488 - 491, 493.1, 493.5, 501, 502.1

Applicant

PALL CORPORATION

1. This written opinion is the first (first, etc,) drawn by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2 (a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. ~~The applicant may, before the expiration of that time limit, request this Authority to grant an extension. See rule 66.2(d).~~

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

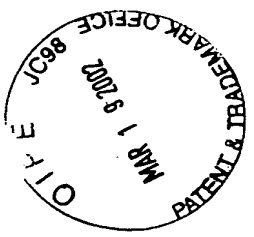
Also For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 *bis*.
For an informal communication with the examiner, see Rule 66.6

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 22 January 2003 (22.01.2003).

Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Marianne Ocampo DEBORAH THOMAS PARALEGAL SPECIALIST Telephone No. (703) 308-0661

Form PCT/IPEA/408 (cover sheet)(July 1998)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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
440327/PALL		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 00/ 26112	22/09/2000	22/09/1999
Applicant		
PALL CORPORATION et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 2

[ ] as suggested by the applicant.

[ ] because the applicant failed to suggest a figure.

[X] because this figure better characterizes the invention.

[ ] None of the figures.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

BELZ, John, M.
Leydig, Voit & Mayer, Ltd.
700 Thirteenth Street, N.W.
Suite 300
Washington, DC 20005
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year) 05 December 2000 (05.12.00)	
Applicant's or agent's file reference 440327/PALL	**IMPORTANT NOTIFICATION**
International application No. PCT/US00/26112	International filing date (day/month/year) 22 September 2000 (22.09.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 22 September 1999 (22.09.99)
Applicant PALL CORPORATION et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An **asterisk(*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
22 Sept 1999 (22.09.99)	60/155,138	US	28 Nove 2000 (28.11.00)

The International Bureau of WIPO
34, chemin d s Col mbettes
1211 G neva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Somsak Thiphrakesone

Telephone No. (41-22) 338.83.38

WO 01/21279
PCT/US00/26112

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:
BELZ, John, M.
Leydig, Voit & Mayer, Ltd.
700 Thirteenth Street, N.W.
Suite 300
Washington, DC 20005
ETATS-UNIS D'AMERIQUE

APR 10 01

Date of mailing (day/month/year) 29 March 2001 (29.03.01)	
Applicant's or agent's file reference 440327/PALL	**IMPORTANT NOTICE**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/US00/26112	22 September 2000 (22.09.00)	22 September 1999 (22.09.99)

Applicant
PALL CORPORATION et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AG,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CR,CU,CZ,DE,DK,DM,DZ,EA,EE,EP,ES,
   FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,
   MN,MW,MX,MZ,NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   29 March 2001 (29.03.01) under No. WO 01/21279

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des C lombettes
1211 Geneva 20, Switzerland

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Authorized officer
J. Zahra

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PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

INFORMATION CONCERNING ELECTED OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

To:

BELZ, John, M.
Leydig, Voit & Mayer, Ltd.
700 Thirteenth Street, N.W.
Suite 300
Washington, DC 20005
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year)	
24 July 2001 (24.07.01)	
Applicant's or agent's file reference 440327/PALL	**IMPORTANT INFORMATION**

International application No.	International filing date (day/month/year)	Priority date (day/month/year)
PCT/US00/26112	22 September 2000 (22.09.00)	22 September 1999 (22.09.99)

Applicant
PALL CORPORATION et al

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

   EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE
   National :AU,BG,CA,CN,CZ,DE,IL,JP,KP,KR,MN,NO,NZ,PL,RO,RU,SE,SK,US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

   AP :GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZW
   EA :AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
   OA :BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG
   National :AE,AG,AL,AM,AT,AZ,BA,BB,BR,BY,BZ,CH,CR,CU,DK,DM,DZ,EE,ES,FI,GB,
   GD,GE,GH,GM,HR,HU,ID,IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MW,
   MX,MZ,PT,SD,SG,SI,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,ZW

3. The applicant is reminded that he must enter the "national phase" **before the expiration of 30 months from the priority date** before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing , if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

   Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

   The entry into the European regional phase is postponed **until 31 months from the priority date** for all States designated for the purposes of obtaining a European patent.

The International Bur au of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switz rland

Facsimile No. (41-22) 740.14.35

Authorized officer:
Odile ALIU

Telephone No. (41-22) 338.83.38

PA ENT COOPERATION TREAT

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 24 July 2001 (24.07.01)	
International application No. PCT/US00/26112	**Applicant's or agent's file reference** 440327/PALL
International filing date (day/month/year) 22 September 2000 (22.09.00)	**Priority date** (day/month/year) 22 September 1999 (22.09.99)
Applicant WILLIAMSON, Kenneth, M. et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

23 April 2001 (23.04.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/26112

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D29/23 B01D29/41 B01D29/01 B01D29/21

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 605 746 A (SERAD GEORGE A ET AL) 25 February 1997 (1997-02-25) abstract column 1, line 15 - line 27 column 2, line 8 - line 40 column 8, line 8 -column 9, line 16 column 10, line 13 - line 34 claims; figures	1,5-7, 18,20,21
Y		2,4, 8-10, 22-29

Y	US 5 543 047 A (STOYELL RICHARD C ET AL) 6 August 1996 (1996-08-06) cited in the application the whole document	2,4, 8-10, 22-29

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2001	21/02/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hilt, D

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 00/26112

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International Application No
PCT/US 00/26112

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 265 089 A (R.W. NUTTER) 1 March 1972 (1972-03-01) page 1, line 35 - line 50 page 2, line 82 -page 3, line 50 claims; figures 2,3	1,3,7,8
Y	---	11,29
Y	DE 42 17 159 A (SEITZ FILTER WERKE) 25 November 1993 (1993-11-25) abstract claims; figures	11,29

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A	US 4 250 172 A (HAUSHEER HANS P ET AL) 10 February 1981 (1981-02-10) the whole document	1,6, 12-15, 18-23, 29-31

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